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A GREAT STEAMER.

THE Gothic is the name of a large twin-screw steamer just from the yard of Messrs. Harland & Wolff, Belfast, and is the latest addition to the well-known fleet of the White Star line. Her dimensions are: Length, 490 ft. between perpendiculars; breadth, 53 ft.; depth of hold, 33 ft.; and gross tonnage, 7,720. She has been specially designed for the New Zealand service, and will be dispatched from London by the Shaw, Savill & Albion Company on her first voyage, on December 28, calling at Plymouth, Teneriffe, Cape Town, and Hobart on her outward passage, and Rio de Janeiro and Teneriffe on her homeward. The distance traversed on the round voyage exceeds 26,000 miles, and in thus for the first time introducing a double set of full-powered engines propelling twin screws into the New Zealand trade, the owners of the White Star line and the Shaw, Savill & Albion Company believe they are acquiring an additional element of safety. Unrivaled accommodation of the highest class, similar in character to that which has been so much appreciated in the Teutonic and Majestic, is provided for 104 saloon passengers amidships, the dining saloon and many of the superior state rooms being above the main deck, so that the ventilation is as complete as possible, and in the control of passengers themselves. In the quarterdeck aft there is accommodation of a unique character for 114 steerage passengers.

In addition to ordinary coal and cargo space, the Gothic has an insulated capacity in the refrigerated chambers capable of stowing some 75,000 carcasses of sheep, the temperature of which is maintained and regulated by two of Hall's most powerful carbonic anhydride machines, which have proved so successful in the large freezing establishments in New Zealand. Special provision has also been made for the conveyance of dairy produce, the export of which is a new development in the industry and enterprise of the New Zealanders, and one which has found great favor with consumers at home. The Gothic is the largest steamer as well as the largest carrier in the Australasian trade; and as a new departure, her appearance is a matter of much interest to colonial shippers. She is the largest ship, with the exception of the Great Eastern, which has ever entered the port of London.

THE BELDUKE PROPELLER.

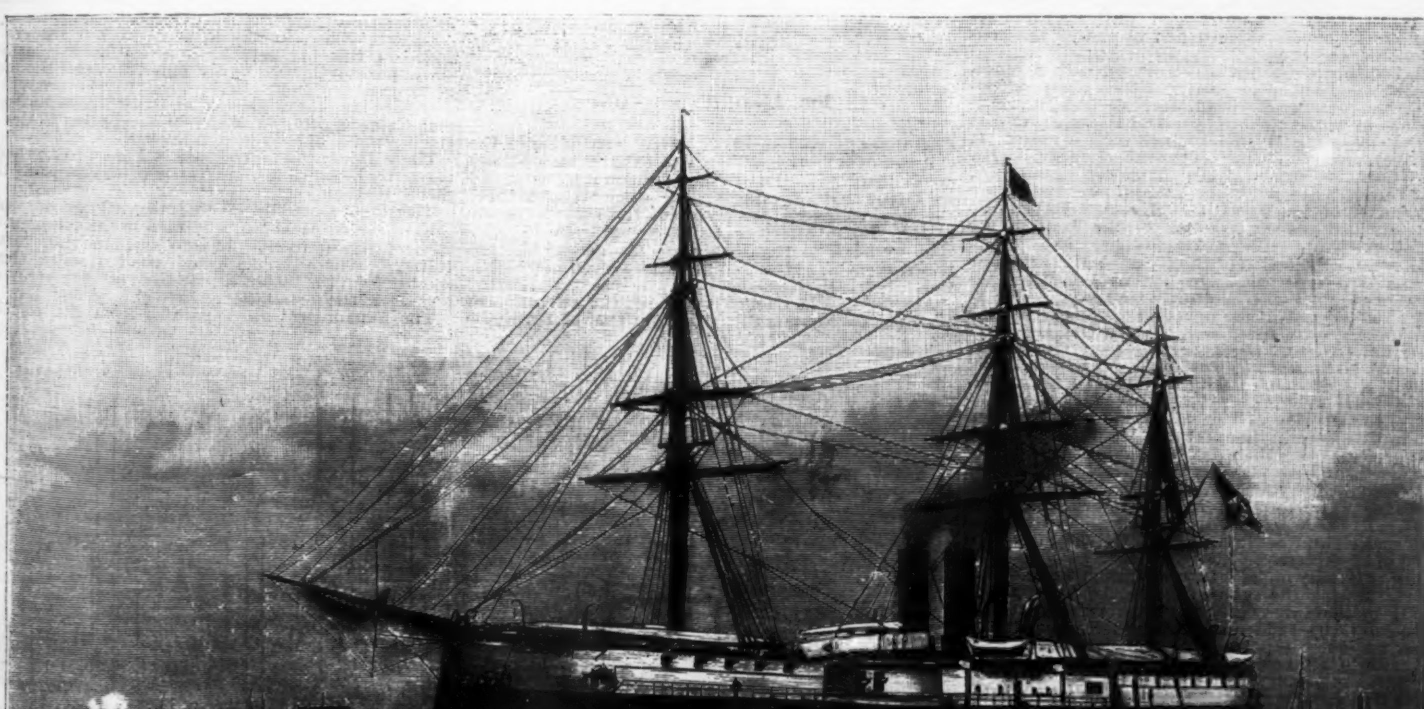
THE illustration shows a pattern of screw propeller which has been the result of an investigation into the subject of screw propulsion, undertaken by Mr. Joseph Belduke, of San Francisco, and which has been tested in practice with encouraging results. The design will be evident from the view we give, and we are promised further particulars at a later date. It is well known that the French

government have in their archives some three thousand different patterns of screw propellers, and it would be interesting to hear whether one similar to the Belduke is contained in the collection. The present form of the propeller is based upon the analogy of the screw, and originated in the cross-section of a bolt cut at a right angle. A general reduction of the blade at the point has taken place, and at the same time an increase in the boss, with the object of passing the water aft as uniformly as possible. Modern practice has shown that one-third of the tip-to-tip of blade diameter may be filled up without any perceptible difference in speed, thereby conceding the ineffectiveness of a large portion of the diameter. The action of the blades at starting is to cause one component of the force to tend to pull down the stern of the vessel, and this is readily noticed in launches. In the case of the new design it is claimed that a saving of power of from thirty to forty per cent. is effected, and the slip is reduced to thirteen per cent., while the vibration is materially reduced. Trials with a hundred-foot yacht on the Hudson River; with the screw yacht Restless and a tug boat tested at Havre have gone to substantiate some of these claims, although in the last case the propeller was 8 ft. 6 in. in diameter, and in the others particulars are not given, so that it is impossible to say whether the design or mere size is the explanation of the satisfactory results so far obtained. A propeller of this design was also tried on second class torpedo boat No. 66 at Portsmouth, which, with her standard type of propeller, gave fourteen knots, while with one of the new pattern nineteen knots were obtained, with a diminution of one hundred revolutions, six hundred and twelve and five hundred odd respectively. A similar pattern of propeller is due to Ericsson, and good results were obtained with it in the American navy, but the type does not seem to have survived.—*Industries.*

THE SUBMARINE BOAT GYMNOTE.

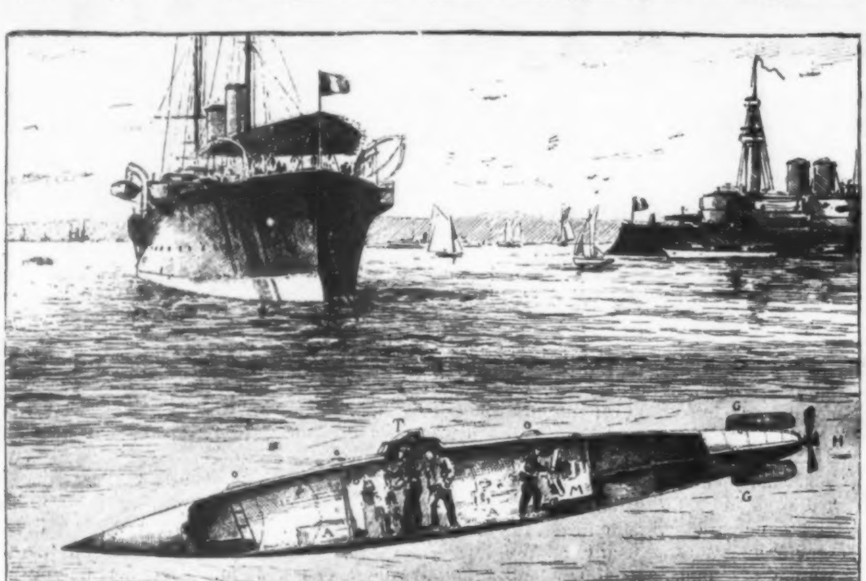
THE submarine boat is destined to render immense services to science by allowing of the exploration of the unknown regions of the bottom of the sea. It almost realizes the ingenious idea of Jules Verne, popularized by his famous romance, "Twenty Thousand Leagues under the Sea." It may also be considered a formidable engine of war. From this standpoint its *role* has not as yet been well defined, but it can already be admitted that a flotilla of submarine boats would lend valuable aid to the defense of our coasts. It would render a blockade impossible and a bombardment dangerous, and would notably modify the rules of naval strategy.

It is in France that has been found the first practical solution of submarine navigation. The tentatives made in recent years in England and the United States have been marked by signal failures. We owe this



THE INSURGENT BRAZILIAN WAR SHIP AQUIDABAN.

admirable invention to a French engineer, Mr. Zede, ex-director of our naval constructions, who established the plans of a submarine boat with so much science that all his anticipations were realized at the first stroke. He conceived the ingenious idea of the application of the electric motor to submarine locomotion. This motor undergoes no loss of weight during its



THE SUBMARINE BOAT GYMNOTE.

operation, requires no oxygen, disengages no gas, and is consequently wonderfully well adapted to navigation under water.

Gymnote is the name that Mr. Zede has given to his submarine boat. Its form is that of a very tapering spindle, since it is 18 meters in length by 1·8 meter in diameter. The boat has a displacement of 30 tons. Its speed reaches from about 9 to 10 knots. Its immersion is regulated, not by the introduction of water in variable quantity into its reservoirs, but by the simple action of horizontal rudders analogous to those of the Whitehead torpedo. The maneuvers are executed electrically. It is thus that it controls its pumps, provides for its lighting, etc.

Captain Krebbs and Engineer Romazzotti were valuable colaborers of Mr. Zede, the first named occupying himself with the electric part. The motor adopted, which is of 55 horse power, is extremely light. It actuates the screw directly without gearing, and communicates to it a velocity of 200 revolutions. Its weight is about 2,000 kilogrammes. The current that supplies the motor is furnished by Commelin-Desmazures accumulators. Mr. Romazzotti had in charge the construction of the boat.

Mr. Zede's experiments, which caused such a sensation in France and other countries, took place at Toulon, in the presence of Vice-Admiral Charles Duperre.

When in service, the Gymnote has a crew of but three men—a captain, an engineer and a sailor. It had five persons on board on the day of the trial—Mr. Zede, Captain Krebbs, Naval Engineer Romazzotti, Naval Lieutenant Baudry de Lacantinerci, the future commander of the vessel, and Foreman Picon, who superintended the construction of the boat in the Mourillon slip.

Upon the submersion of the Gymnote, its tightness was found to be perfect, and the plunging and ascending were executed with admirable facility.

The rudder and motor operated perfectly, and the boat preserved its speed well close to the surface of the water. After taking its accumulators aboard, the boat with all its *materiel* was found to be in a perfect state of submersion. Ready to continue its experiments, it was steered over the roadstead outside of the lines of the moorings. The submarine boat was then seen to dive several times for a few minutes; come to the surface again; then descend again to a depth of four meters and reappear at the surface, and all this with extraordinary facility. Then, suddenly descending in the water to a depth of seven meters, it reappeared after traversing a distance of about five hundred meters, and having preserved in the interval a speed of ten knots.

During its stay under water respiration was not impeded. During the submersion the boat took on a rolling motion; its engine worked fore and aft with sureness, and the rudders operated to perfection. Those present at these experiments could not conceal their real feelings, not being able to believe in so perfect a result.

The Gymnote was then recognized as a formidable engine of war, and, as soon as it was provided with its military apparatus, it took a rank among the movable vessels of defense of the port of Toulon.

The inventors are now pursuing their experiments with the object in view of improving the boat, which, in fact, is but an experimental one, designed to demonstrate the possibility of subinarine navigation.—*La Science Moderne.*

AMMONIA MOTORS.

THE use of ammoniacal gas for the production of motive power has already been the object of numerous tentatives, which, as well known, have not, up to the present, given very practical results or sufficiently economical rendering to compensate for the increase of the cost of installation.

It is permissible to hope that the new researches made in this direction in America, in utilizing ammonia no longer in aqueous solution, but in an anhydrous state, will have better results.

Even if success should not respond completely to the hopes of the promoters, these new tentatives would, nevertheless, preserve a very interesting character, and so much the more so in that at present the companies carrying passengers in cities appear to be favorably disposed to substitute mechanical for animal traction.

It is well known that, at a temperature of —39°, ammoniacal gas liquefies at the pressure of the atmosphere, and that the same phenomenon occurs at + 21° under a pressure of 10 to 13 kilogrammes per square centimeter. In this last state, the expansion of the ammoniacal gas produces a great depression of the temperature that it is important to avoid. To this effect there is utilized the powerful affinity of ammonia for water, which absorbs as many as seven hun-

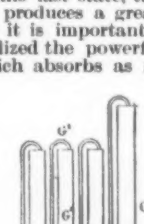
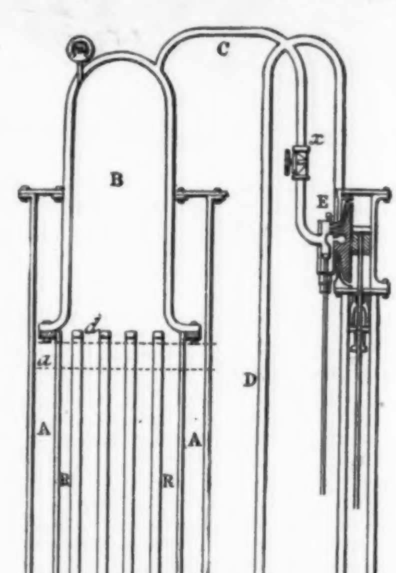


FIG. 2.—DEHYDRATOR.

dred times its volume of it. After expanding in the cylinder of a motive piston, the exhaust ammoniacal gas is dissolved in the water, to which it gives up all its latent heat of vaporization, which serves to heat the liquid ammonia reservoir and the cylinder of the motor. It can afterward be recovered from this solution by heat, so that the ammonia accomplishes a closed cycle, as in the well known ice machine of Mr. Carré, in which the phenomena are almost identical.

Among the old ammonia engines, the operation of which is based upon this principle, that of Dr. Emile Lamm is the most remarkable. In 1870 he pointed out, as the characteristic of his system, the transmission of the latent heat of the gas to the water of absorption, and then of this latter to the liquefied gas, in order to keep up its evaporation.

The annexed figure gives a diagram of this motor. R R is a receptacle containing anhydrous liquid am-



LAMM'S AMMONIA MOTOR.

monia up to the level, d, and surrounded by the reservoir, A A, containing, up to the line, a, a weak ammoniacal solution that fills the tight tubes of the receptacle, R. Ammoniacal gas at a high pressure fills the dome, B, of the latter and is capable of being sent, through the conduit, C, and the cock, x, into the distributing box, E, of the motor. It escapes therefrom through the pipe, D, which debouches at the bottom of the reservoir, A, where the dissolving of it is effected. At the beginning of the work the motor operates at a pressure of 10·5 kilogrammes per square centimeter, at a temperature of 32° C., which the ammonia reservoir must preserve during the whole time of the operation.

One of the principal difficulties experienced in the treatment of the aqueous ammoniacal solution, enriched by the exhaust gas, consists in its conversion into anhydrous liquid ammonia. If the latter is not entirely deprived of water, its efficiency for the production of motive power will be diminished. So one has been led to the establishment of complete installations for the production of anhydrous ammonia, but which, in an exploitation of tramways, is of a nature to sensibly increase the expenses of the first establishment.

We are going, moreover, to allow our readers to judge of this in describing in a very detailed manner the apparatus devised by Mr. MacMahon for the recuperation of the ammonia employed for the propulsion of cars in a motor of his system, which some time ago made considerable of a stir in the United States at the beginning of the Chicago Exposition.

These apparatus, represented in Figs. 1 to 3, are permanently installed in the vicinity of the tramway line served by them.

The liquid ammonia, or concentrated aqueous solution of ammoniacal gas, is treated in the extractor, A, which it fills up to A^3, that is to say, much above the tubes, A^1, where enters through the bottom the steam coming from the boiler, E^2, situated at the right extremity of the installation.

The ammoniacal gas separates from the solution

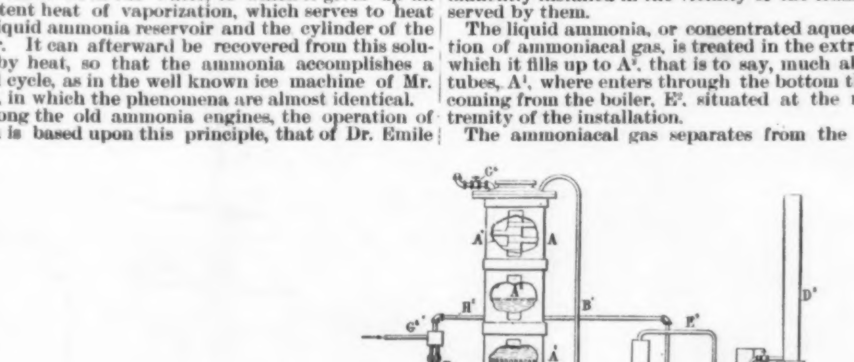


FIG. 1.—INSTALLATION FOR THE DEHYDRATION AND RECOVERY OF AMMONIA.

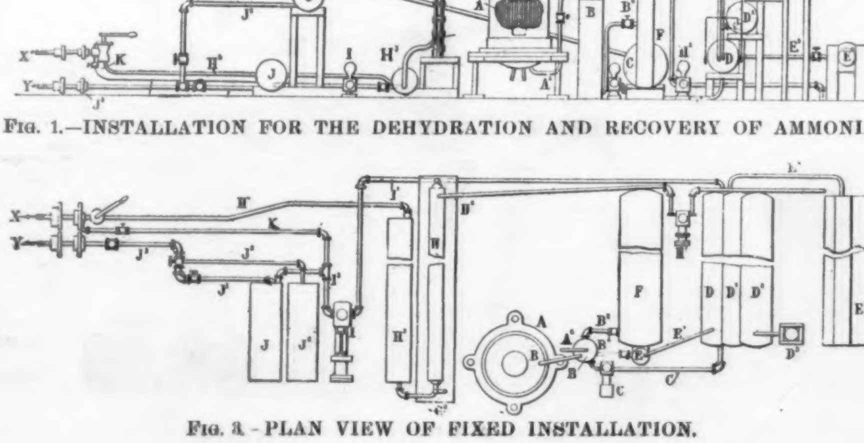


FIG. 3.-PLAN VIEW OF FIXED INSTALLATION.

thus heated and enters the dehydrator, G (Fig. 2), which surmounts the extractor, A, and which is figured isolatedly at its left, in order to facilitate the grouping of the figures of the plate. Here the ammoniacal gas traverses in succession the cylinder, G¹, and the vertical driers, G², the water from which returns through the conduit, G³, and the cock, G⁴, to the extractor, A, where it falls in a cascade upon the diaphragm, A², to mix anew with the solution under treatment.

The gas thus dehydrated enters the condenser, H it and enters the reservoir, D, through the conduit, E³. The residuum is removed from the boiler and either thrown away or utilized as a fertilizer, while the level in the column, D², is re-established by an addition of water.

Such are the various operations that take place in the stationary installation for treatment of ammonia.

Let us now pass to the apparatus arranged under the box of a MacMahon locomotive and represented in Figs. 4 to 10. A tight cistern, A, containing a weak solution, surrounds and supports a cylinder, B, between it to D (Fig. 1). So, too, after the exhaust of the motor has concentrated the solution of the receiver, it is discharged through J², Y J₁, under the suction effected at I² by the same pump, I².

The charging of the cylinder, B, is done up to the level, 1—2, a little beneath the port, D (Fig. 6), and the weak solution, designed to absorb the ammoniacal gas, is introduced a little higher up at 3—4. In measure as the work proceeds, the level at B descends, while it rises at A.

As may be seen (Fig. 6), thin partitions, B², unite

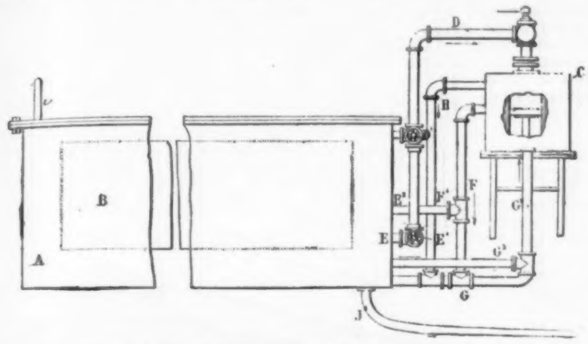


FIG. 4.—MOTOR WITH ITS WEAK SOLUTION AND ANHYDROUS AMMONIA CISTERN.

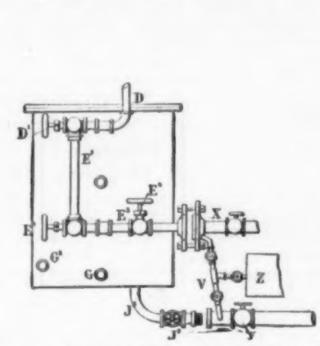


FIG. 5.—CHARGING OF THE CYLINDER AND ITS CISTERN.

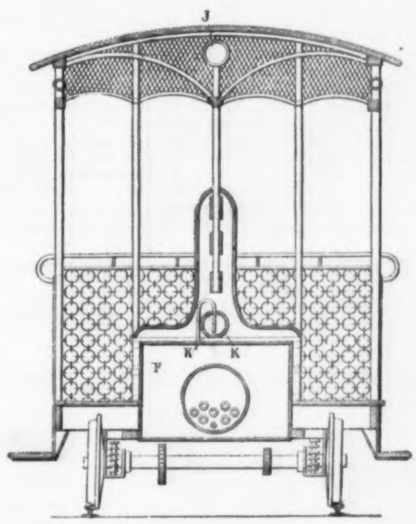


FIG. 12.—CROSS SECTION OF THE CAR.

(Fig. 1), through the pipe, G₁, placed at the point of origin of a worm, upon which a box with a perforated bottom allows to fall a shower of cold water continuously led by the pipe, H₂, from the pump, H₁. The anhydrous ammonia thus obtained flows into the receptacle, H₃, and thence reaches the conduit, H₄, whose valve cock supplies the conduit, X, connected with the motor.

The ammoniacal solution, from which the gas is separated, is sent in a continuous manner into the extractor, A, by means of the feed pump, C, which lifts it through the pipe, C¹, into the reservoir, D, and forces it through the temperature exchanger, B, whose vertical conduit, B¹, debouches at the top of the extractor, A, where the solution falls in a cascade upon the diaphragms, A².

The impoverished solution is continuously removed, through the pipe with cock, A³, from the bottom of the extractor, and led through the exchanger in a

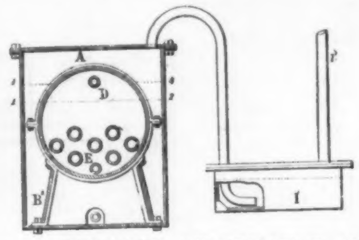


FIG. 6.—PURIFIER OF EXHAUST AIR.

direction opposite that of the richer solution, which rises at B¹. It is afterward sent either directly through B² into the reservoir, F, or by preference through the conduit, B³, into the column, E, which, not being under pressure, allows every facility to the ammoniacal gas still dissolved to disengage itself. This gas escapes through E¹ into the solution of the reservoir, which thus becomes concentrated to the detriment of the solution reaching E, and which flows into the horizontal reservoir, F, and then, through the conduit, F₁, into the cistern, J¹, containing a weak solution. This latter is afterward utilized in the apparatus of the automobile car, to which it may be sent by the branches, J² and J³, of the conduit, T. It serves to reabsorb the exhaust gas of the motor. Once concentrated anew, it is replaced at the same time that the supply of anhydrous ammonia in the locomotive is renewed.

In order to replace this solution, the return piping,

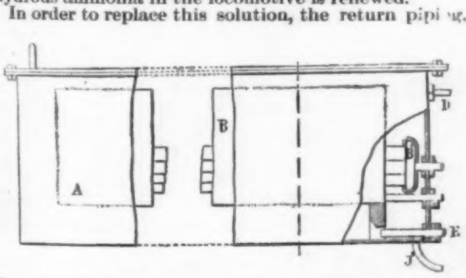


FIG. 7.—CISTERNS FOR EXHAUSTED SOLUTION OF ANHYDROUS AMMONIA.

Y J² and J₁, is employed, which leads it into the cistern, J, where it is regularly sucked up by I, into the pump, I, flowing back at I, into the lowermost of the superposed reservoirs, D, D₁, D² and D³, established to the right of the installation. These reservoirs are filled with water, but the column, D³, is only partially so. They are connected in couples by pipes provided with cocks, actuated by means of levers, in such a way that the liquid of the column can pass in succession from one to the other of these reservoirs.

The concentrated solution coming from the motor mixes with the water of the reservoir, D. The gas in excess passes at D₁, then at D₂, and finally into the column, D₃, where it becomes absorbed, so that the air that the gas may have carried along may be allowed to escape through the top of the column. As for the lubricating oils, they are got rid of by sending the upper layers of water of the column, D³, into the boiler, E², which furnishes steam to the extractor, A. The ammonia, still dissolved in this water, separates from

the bottoms of which extend tubes that in front debouch through ajutages in the chamber, B₁ (Fig. 10).

Alongside of these apparatus we find the engine (Fig. 4) into the cylinder, C, of which the ammoniacal gas is admitted through the valve of the conduit, D, as well as through the pipe, E, starting from the receptacle, B, containing anhydrous liquid ammonia. Between the cocks, E₁ and D₁, of these conduits is interposed a glass tube, E², that shows the level.

The exhaust from the motive cylinder takes place through the pipe, F, which carries a branch, F₁, that debouches in the chamber, B₁, of the receptacle, A, and afterward communicates through a prolongation with the pipe, G, ending at the bottom of the jacket of this cylinder; finally, at the top of the jacket is the waste-pipe, H, which also is united at G.

The escapement of the air for the purging of the ammoniacal gas is assured in an ingenious manner. Upon the back of the receptacle, A, there is a pipe, *i*, that debouches above the level of the water contained in the box, I (Fig. 6). The ammoniacal gas coming from the cistern, A, dissolves in this water, whence it may be recovered, while the air carried along escapes in

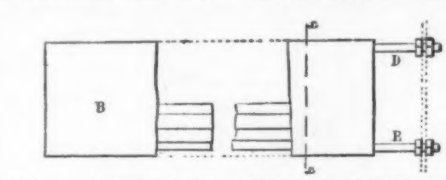


FIG. 8.—ANHYDROUS AMMONIA CISTERN.

bubbling through the conduit, *i*₁. In this way are prevented not only losses of ammonia and its disagreeable odor, but also a counterpressure back of the motive piston.

By reference to Fig. 5 it will be seen that with the bottom of the level indicator is connected, perpendicularly to the conduit, E, the pipe, E³, provided with a check valve, E⁴, and flanges for its junction with the piping, X, which is traversed by the anhydrous ammonia obtained in the fixed installation.

This liquid enters the cylinder, B, through the cock, E⁵, and under pressure. Previously a partial vacuum has been formed in the conduit, X, by means of a small pipe, V, leading to a box, Z, connected with the vacuum pump, I, through the pipe, K (Fig. 1).

The receptacle, A, carries also a charging conduit, J³, with a cock, J⁴, for the introduction of a weak ammoniacal solution by means of the conduit, Y, starting

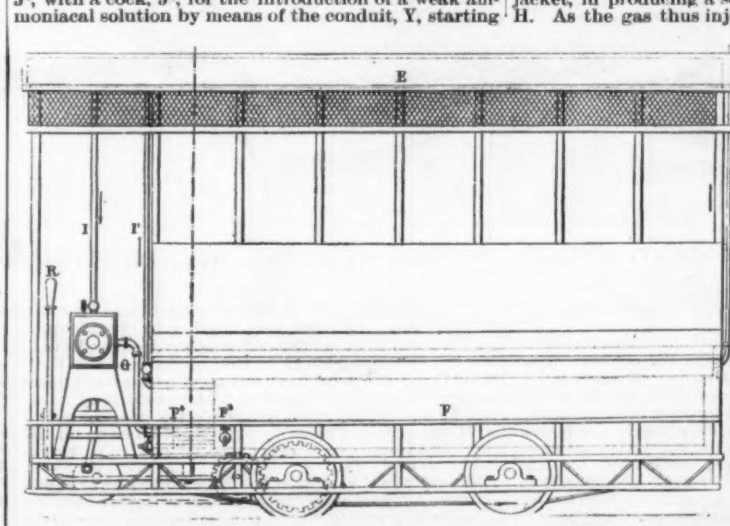


FIG. 11.—CAR ACTUATED BY AN AMMONIA MOTOR.

from the reservoir, J⁴, of the plant, and in which also a vacuum is made by the pipe, V, before the charging.

Inversely, if, for any reason whatever, it were of interest to discharge the cylinder, B, it would be effected through X, after closing the conduit, H⁴, this permitting the pump, I, to suck up the liquid at K and force

the supports of the cylinder, B, in pairs longitudinally, and extend throughout its entire length. Their object is to cause a circulation of the solution in the receiver, A. In fact, the lower and central liquid stratum which receives the exhaust of the gas becomes heated in absorbing it, and circulates along the partitions until it reaches their opposite extremity. In this travel it becomes progressively cooled, and then circulates to the exterior of the partitions from back to front. This continuous motion of the solution, beneath the cylinder, B, as well as in its tubes, facilitates the absorption of the gas and the exchange of temperatures.

Let us now examine the operation of the motor,

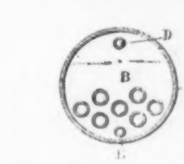


FIG. 9.—SECTION THROUGH *x x*.

which, to tell the truth, is studied in a very summary manner from the standpoint of its mechanism. The ammoniacal gas is admitted through the cock, D₁, and the stop valve. Once the stroke of the piston accomplished, the gas escapes at F. One portion goes through F₁ into the chamber, B₁, and penetrates the ajutages of the tubes of B, where it causes a circulation of the weak solution. The other part of the exhaust debouches in the lower conduit, G, and distributes itself therein to the right and left. At G₁ this gas betakes itself to the jacket of the motive cylinder and causes the circulation therein of the solution, which, through the waste-pipe, D, reaches the receiver, A. Through its disengagement to the left of the conduit, G, where there is a sort of injector, the rest of the exhaust aids, besides, the circulation in the cylinder jacket, in producing a sort of suction in the conduit, H. As the gas thus injected is immediately absorbed

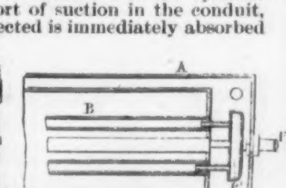


FIG. 10.—LONGITUDINAL SECTION OF THE CISTERNS.

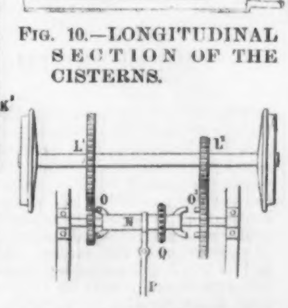


FIG. 13.—MECHANISM OF PROPULSION.

by the solution that traverses the tube, G², supplying the jacket, C, and to which it imparts its latent heat, the jacket not only does not become cool during the work, but even becomes heated, despite the lowering of the temperature produced in the motive cylinder through the expansion of the gas. The same is the case in the receiver, A, so that the evaporation in the

cylinder, B, is kept up in a most efficacious and economical manner.

The apparatus that we have just described are arranged upon the passenger car, represented in Figs. 11 and 12. Beneath the seats is established the weak solution cistern, F, which receives the exhaust of the motor through the pipe, G. The interior anhydrous ammonia cylinder communicates through the conduit, I', with a gas reservoir, J, placed under the roof, E, of the vehicle in order to play the role of a drier and serving the motor in its turn by means of the pipe, I. A purger, K, mounted upon the cistern, F, with a siphon, K', has its exhaust pipe at K². Finally, F³ designates the charging cock of the reservoir, F, and F⁴ that of the interior cylinder.

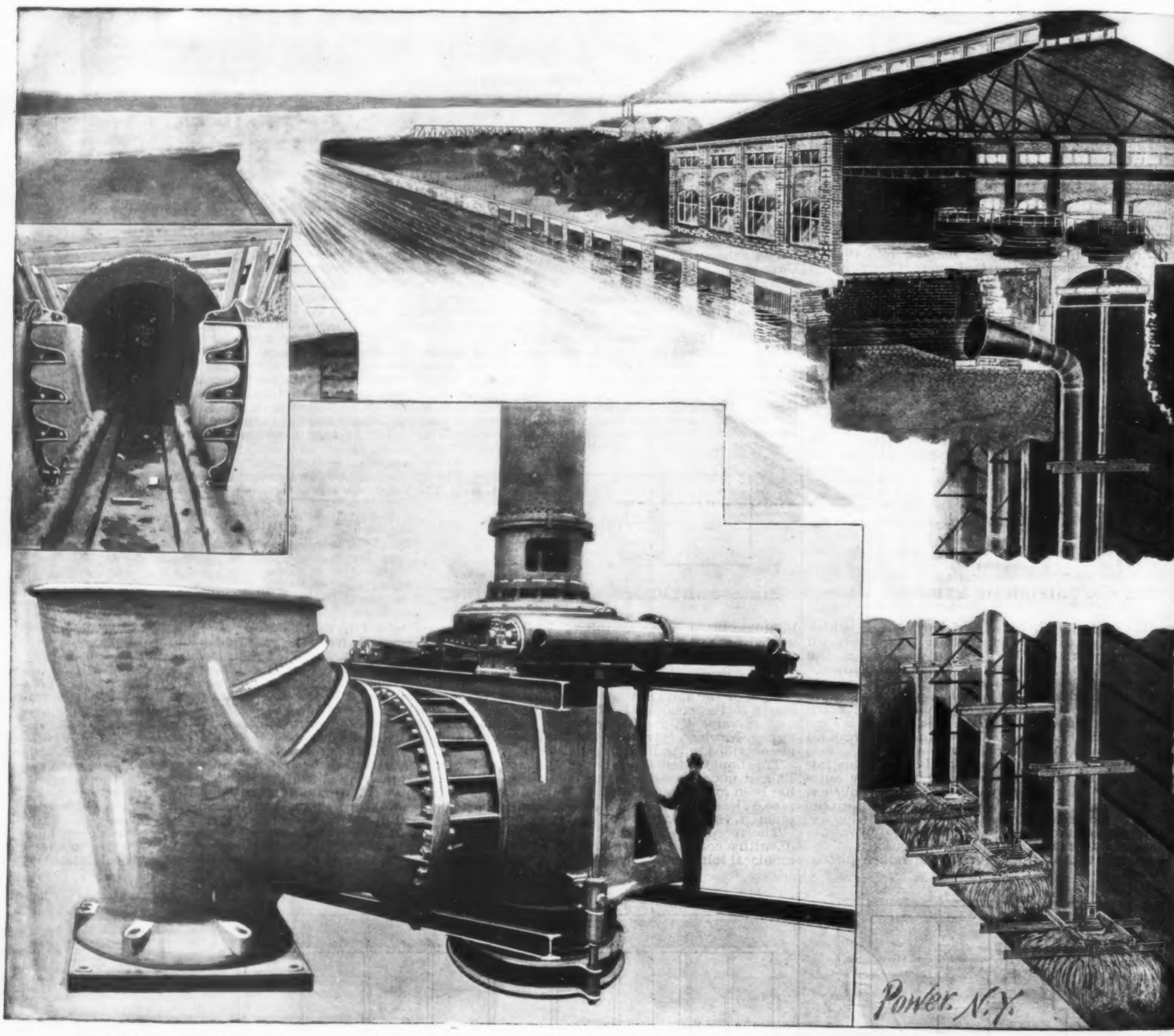
The motor is arranged at one of the extremities of the car. Its mechanism is shown in the figure only by way of example. It actuates an axle (Fig. 12) through an intermediate shaft, N, and either of the two-speed gearings, L', L². Upon this shaft there is a coupling box maneuvered through the rod, P, connected with the lever, R, placed near the motor. According to the position of this box, one or the other of the gearings, OO', participates in the motion of the shaft, N, which is actuated by the motor through a chain pulley, Q. This coupling box may likewise be made to occupy its mean position, so as to stop the car without arresting the operation of the motor.

A MacMahon motor, constructed by way of experiment, was exhibited at the Chicago Exposition. The vapor produced by the anhydrous ammonia kept a temperature of 25° or 26° through the absorption of its latent heat of vaporization in the water of circulation, and was distributed alternately over the two surfaces of the piston of the motor. At the start, the pressure fell to 9 kilogrammes per square centimeter, but under way it soon rose to 11 and even 12 kilogrammes; thus showing the increase of temperature due to the condensation of the exhaust of the ammoniacal gas.

The charging of a new supply of anhydrous liquid ammonia sufficient for a run of 29 kilometers, and the extraction of the concentrated bath in which the ammonia is recovered, were, it appears, effected in two minutes.

If, as is asserted, the tightness of the apparatus permits of preserving the charge intact for any length of time, the sole running expense of this system is thus reduced to the coal burned for the recovery of the liquid ammonia.

The experiments above mentioned were effected in very cold weather, that is to say, under unfavorable conditions. One kilogramme of coal was burned to obtain 8·35 liters of anhydrous liquid ammonia, and, for propelling a car weighing five tons at a speed of 25 kilometers an hour, 14·1 liters per kilometer were consumed. The corresponding consumption of coal was 1·69 kilogrammes, and, at the cost of 35·33 francs per 1,000 kilogrammes of coal delivered at the generating station, the kilometric expense, it appears, did not amount experimentally to 0·06 franc. It would have been interesting had a general idea been given of the expenses necessitated by the installation and the service of the plant. It ought not to be forgotten, either, that apparatus to contain anhydrous ammonia must be of exceptional strength, since, in summer, for example, very high pressures may develop in them that might not be without danger.—*Revue Industrielle.*



FIFTEEN THOUSAND HORSE POWER ELECTRIC GENERATING PLANT AT NIAGARA FALLS.

[FROM POWER.]

THE POWER STATION AT NIAGARA.

BY the time this paper reaches its readers, if the expectations of the builders are realized, the great tunnel at Niagara will have commenced to discharge water, which, instead of falling purposeless over the cliff, has been diverted and applied to useful work. The first mill to make use of the power rendered available by the tunnel will be that of the Niagara Falls Paper Company, who have arranged to use 3,000 horse power at the outset. Interest centers especially, however, in the 50,000 horse power electric station which the Niagara Falls Power Company are erecting on the main canal, and which it is expected will be in operation at an early date.

The units in this station are 5,000 horse power Westinghouse alternating dynamos, each with its revolving field directly connected to the vertical shaft of a 5,000 horse power twin turbine, built by the I. P. Morris Company, of Philadelphia, from designs furnished by the Swiss firm of Faesch & Piccard. The size and appearance of these powerful wheels is shown in the engraving on this page. They are of the Fourneyron or Boyden type, designed to develop 5,000 horse power under about 140 feet head and at 250 revolutions per minute. The turbines are cast of bronze of the same quality as that used for the propellers of steamships. The main canal, on the west side of which the power station is located, is 188 feet wide, and 17 feet deep at the river, narrowing to 116 feet in width, but preserving the same depth throughout its length of 1,260 feet. The water will be carried in the canal to a depth of about 12 feet. The sides of the canal are built of solid masonry, seven feet thick at the bottom, tapering to three feet thick at the top, on which is a coping two feet and a half wide. From this canal the water is taken through a separate inlet for each wheel, and carried through a penstock seven feet in diameter into the center of the turbine. It is then discharged through directing passages, upon the movable blades of the wheel, of which there are 32, the directing passages being formed by 36 deflecting plates.

The shaft is vertical, bringing the wheels proper into a horizontal position, one at the top and one at the bottom of each case; and gates controlled by the governor are made to uncover more or less of the discharge opening, according as more or less power is required. It is expected that the governing mechanism will control the speed under ordinary variations of load within a variation of less than one-half of one per cent., and when one-quarter of the entire load is thrown off at once, the variation of speed is not supposed to be more than three per cent.

To maintain the efficiency of the wheel on less than full gate opening, the discharge passages and blades are divided vertically into three compartments, so that when the gate is only one-third open, for instance, the wheel is in the same condition as to direction and velocity of water discharged upon the blades as though the gate were completely open.

One serious engineering problem to be met in this installation was that of supporting the weight of the long vertical shaft and the attached portions of the dynamo, amounting to about 152,000 pounds, and the enormous downward pressure of the column of water in the penstock. This is solved in this design by closing the bottom of the casing, so that the water cannot act downward upon any of the parts attached to the shaft, while in the upper end of the casing are apertures through which the water can act upon the under side of the disk carrying the movable blades of the upper turbine and relieve the bearings of the weight of the shaft. In this way the weight of the water column is sustained by the stationary portions, which can be braced and supported for the purpose, and the pressure due to the head made to act upward for supporting the weight of the revolving shaft, which is thus

nearly in the condition of a shaft spinning upon the water. The area involved is so proportioned that when the wheels are lightly loaded the upward pressure will be some 2,000 pounds in excess of the weight of the shaft, and when the wheels are running at full gate about the same amount less than the weight of the shaft, on account of the lesser pressure in the casing. This variation in pressure and direction is taken care of by a thrust bearing shown in section in the detail drawings.

The shaft consists of a steel shell about a foot in diameter, with smaller solid portions in the journals, which require to be of less frequency on account of the stiffness due to the large diameter of the hollow shaft. The latter is of rolled steel tubing, without any visible vertical seam. No flywheel is required, sufficient momentum and inertia being furnished by the heavy fields of the dynamo which are carried upon the shaft.

The dynamos are constructed upon the two-phase alternating current system, with stationary armature and revolving fields, and are designed to generate a potential of 2,000 to 2,400 volts, which will be increased or diminished by step-up or step-down transformers for transmission or local use. Motor generators will be run for the production of continuous current when required, so that the station will be able to furnish continuous or alternating current of any potential. Two-phase Tesla motors will be used. The station is designed eventually to comprise ten of the units described, and the wheel pit and building will be extended toward the river and new wheels put in as required. Meantime power from the station itself will be available for carrying on the work, extending the wheel pit and the main tunnel, and the many mechanical operations connected with grading and inaugurating the industrial city which will grow up about this source of cheap and continuous power.

The power house is being built of stone, with a steel frame, and lined with enameled brick. The steel roof of trusses of over 60 feet span rests upon steel posts that serve to carry the girders to sustain a 50 ton traveling crane which commands the entire floor. At the north end of the house the width will be greatly increased, and an L added, extending eastward to the edge of the canal. This L and the enlarged extension of the main building will form the entrance front and will present gable ends to the east and west. To the left of the entrance archway the offices, four stories in height, will be located, wholly in the L, while to the right, including the archway, the whole height of the power house to which it is attached consists of one large room, all accessible to the traveling crane. An arched portal or main doorway of great height forms the entrance vestibule, through which cars loaded to the limit of railway regulation can readily pass into the main power house, through a second lower archway, which in summer will be closed with iron grill work and in winter by doors. Above this second arch will be a medallion of the Indian Chief Ni-a-ga-ra, standing in his canoe shooting the rapids, which has been adopted as the seal of the company. The entrance to the offices is in the left wall of the vestibule, and gives access also to visitors, who, passing a ticket office, gain by an easy flight of stairs a bridge that crosses the great end room of the power station, from which the whole interior may be seen. In this large room will be located the switchboard and testing instruments.

The distribution will be through underground conduits extending in various directions from the station to the principal points of service. A photograph of the conduit in course of construction is shown in the upper left hand panel of the engraving on the opposite page. The conductors will be carried on insulated brackets on both sides. A track extends throughout the length of the conduit, upon which an electrically propelled car will carry the linemen between wire screens that protect them from the dangerous currents through which they pass and allow every portion of the line, brightly illuminated by the passing car, to be thoroughly inspected with absolute safety. The brackets are located 30 feet apart. The concrete casing is made of three parts gravel and one part Portland cement.

One of the largest and earliest consumers of power from this station will be the Pittsburg Reduction Company, whose plant will be located about 2,500 feet from the power house. They will use a current equivalent to about 3,000 horse power in the reduction of aluminum, and light and power will be furnished as fast as the generating and transmitting plant can be put down, not only to the factories which will be erected upon the surrounding land, but to Buffalo and the surrounding country. Experiments are being made to determine the practicability of its use in propelling the boats on the Erie canal. Electricity is the method most in favor for distribution, although Professor Unwin, who is identified with the work, says that power can be transmitted by compressed air to a distance of 30 miles in a 30 inch main, with an efficiency of from 59 to 73 per cent. if reheated, and 40 to 50 per cent. if used cold. In blocks of 500 horse power or less motors will be used. Groups of wheels arranged in sets of five to each pit will be arranged to give power in blocks of 1,000 horse power to a single manufactory, or to several establishments that can combine to use that unit. The cost of excavating the deep wheel pits makes smaller units impracticable by dieret wheels, but more efficiently supplied by electricity from the large generators through which a multiplicity of small powers may be grouped upon one large wheel.

A COMBINED WAGON AND BOAT OF ALUMINUM.

THE combined wagon and boat of aluminum represented herewith are due to the ingenuity of Mr. Jules Claire, a well known explorer.

The wagon, which consists of a tight aluminum box, is very similar to the model used in the Monteil expedition, but differs therefrom in the following modifications.

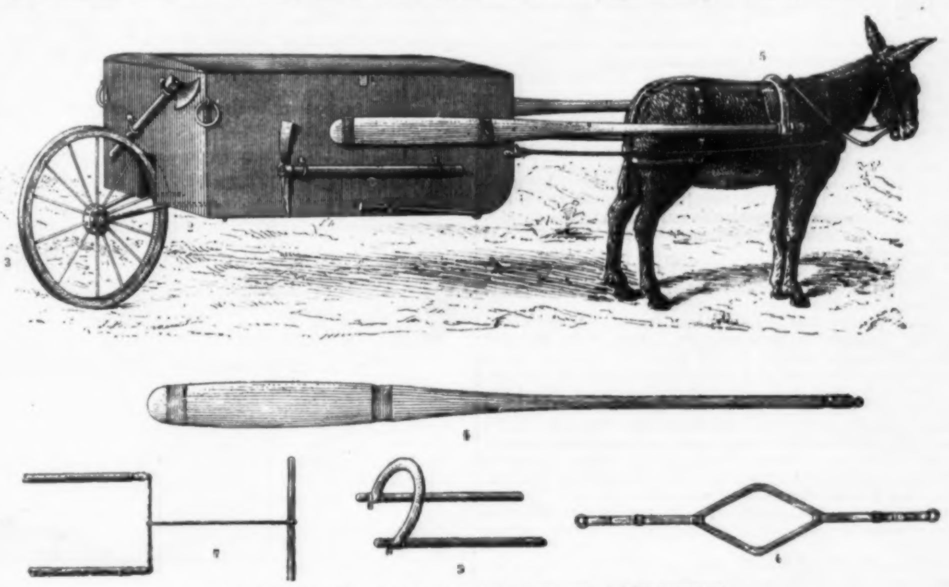
The very light cover (Fig. 1) is reduced to the least weight possible. The box is provided with an aperture behind (Fig. 2) in order to allow the wheel to pass. The vehicle is mounted upon a single wheel Fig. 3), 3·28 feet in diameter, made of hickory, an extremely strong wood, that permits of giving it but a slight width. The thills (Fig. 4) are formed of the oars designed for rowing the boat. A stiff hame of aluminum (Fig. 5) permits of fixing the thills firmly to the saddle of the ass or mule employed. A breast collar of leather (Fig. 6) is designed for the replacing of quadrupeds by man.

The advantages of this system are greater lightness of the vehicle, which two men would suffice to transport in case of need. The use of a single wheel placed in the rear, capable of being easily carried by one man, reduces to three the number of carriers of the complete vehicle, and which is seven at a minimum in the existing models.

But the greatest advantage of this system is that it renders the wagon capable of passing through pathways in which a carrier can walk, and of easily getting over slight obstacles, such as trunks of trees, rocks, etc. Such a maneuver is impossible with a two-wheeled vehicle, not only on account of its greater weight, but because of the spacing of the wheels requiring a sufficiently wide road.

The accessories mentioned above permit of the use of beasts of burden or of men, who can be harnessed to the vehicle in unlimited number, thanks to a pole which can be substituted for the thills.

With this new system of carriage it is possible, in a few minutes, to assemble several wagon boxes in order to form a boat whose oars would be the thills. The explorer will thus be able to cross rivers with safety and carry all the luggage of the expedition. — *Le Magasin Pittoresque.*



COMBINED WAGON AND BOAT OF ALUMINUM.

PROFESSOR WELLNER'S FLYING MACHINE.

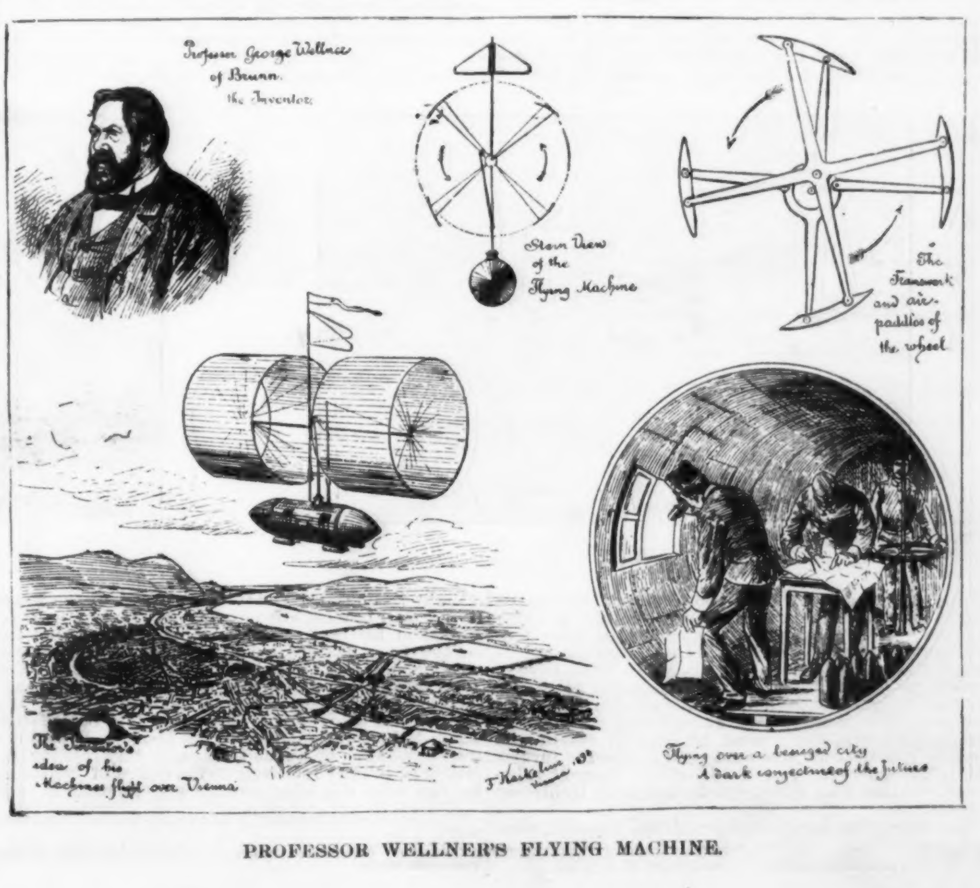
PROFESSOR WELLNER was born at Prague in 1846, and at the Technical School there in 1867 won high honors. He was subsequently engaged as a constructing engineer in several of the big firms in Bohemia. His connection with the Brunn High School commenced in 1876, and on a vacancy occurring during 1886 he was elected to the professorship he now holds. Since 1872 he has visited the various exhibitions throughout Europe. He has written several books. A brochure on "The Possibility of Air Ships," published in 1876, was issued again in substantial book form in 1880. He contributes many articles on technical subjects to magazines. His public work has been confined to the Bohemian Landtag, of which body he was elected a member in 1883.

"I am sorry," observed the professor to us, as we sat together in his house on the Franzen Glacis of Brunn, "that I can only illustrate by diagrams and the models of its parts what I am sanguine enough to consider the flying machine of the future. As you are aware, a sum of money is being raised at present sufficient to cover the cost of a trial machine. This means a delay of a month or so, and then you will be able to definitely judge for yourselves, as the first ascent will probably be made from Vienna. But let me explain to you the construction and principles of the machine.

"My hope of its future success lies in the construction of the sail wheel. It was patented in England in May of this year as 'a rotary sail for flying machines.' It is an invention of my own. The wheel works on a fixed eccentric, and the air blades attached to the spokes have thereby an oscillating as well as a rotary motion, as this model here shows. Observe that when this air blade reaches the highest part of its circle, and just when about to descend, the oscillation of the eccentric causes it to suck in the air and force it downward into the inside of the wheel. There are four blades to each wheel, and canvas is stretched over the same, giving the resemblance of a drum open at both ends. This is the main secret of the machine—this rotatory oscillating blade motion, that gives it support in the air and a rapid forward motion; the rest are mere details."

"And these mere details are what?" I inquired.

"A small car, a compressed air engine, steering gear, and a crew composed of two individuals—a steersman and an engineer. But this is for a flying machine of the smallest description. I have measurements for machines to carry also four, eight, sixteen, and twenty persons. The latter number is, I think, the safe



PROFESSOR WELLNER'S FLYING MACHINE.

maximum, though greater calculations could still be carried out. For eight persons steam engines must be substituted of at least 200 horse power. Sufficient for a primary trial, however, is the small flying machine to carry two persons. It will cost between £2,000 and £2,500 sterling. It will be constructed out of the finest steel. The framework will be excellently put together, and the tubes will be hollow. The sail wheels possess a diameter of 15 feet and a length of 12½ feet. The cigar-shaped car will be 5½ feet in height inside and 12 feet in length. The compressed air strength of the engine must be 25 horse power, and the entire weight carried—including car, engine, framework, sail wheels, and the two men inside—16 cwt. These then are the measurements.

"Now suppose we are inside the car and ready to start——"

"I'd prefer always to be a spectator," I remarked. "But go on, professor; I am in imagination watching the proceedings inside, through one of the car windows!"

"Good. The car is resting upon a clear space of ground, slightly sloping outward. The engines start at '180 revolutions' a minute, and we soar upward at an angle of 28°. When the car, after an interval of 80 seconds time, reaches an elevation of 150 feet, I signal to the engineer for '135 revolutions,' and then the flight is one horizontal with the earth. At '135 revolutions' the car remains stationary, so far as altitude is concerned."

"And doubtless the speed is terrific," I observe, with interest awakened by Professor Wellner's enthusiastic delivery.

"Yes; pretty fast. I calculate upon a speed of all but 1½ English miles a minute. And thus the car rushes through space. I will guide it with the helm above the sail wheels as a ship is controlled on the sea. It moves to the right or left on the same principle. When I wish to check the speed, without diminishing the revolutions, I open out the helm like a fan. In descending, the angle is the same as when rising, namely, 28°. The car sweeps down on the earth again as lightly as a bird. I expect no trouble from my invention, and I have the utmost confidence in it."

"Excuse my doubting faith, professor, but if something went wrong with the engine's works! What next?"

"All up! Utter ruin! But personally I have no dread of such a contingency, and when the opportunity I am so longingly waiting for arrives, you can judge for yourself."

IN TIME OF WAR.

"And should the air ship ever gain public confidence," continued Professor Wellner, "for passenger traffic between towns, there is another important sphere for its usefulness."

"For war purposes," I interrupted.

"Yes. High in the air it seems only a white shred, and a bullet bores through the wooden air blades or glints off the steel framework. A bullet leaves no such disastrous effects as on the silk work of an inflated balloon."

"May I ask if any European war office officials have been in communication with you?"

"Yes, several. But on this point of the question I'd rather give no information. It will add further horrors to war when daring officers can speed over an invested city——"

"And drop down upon its buildings such commodities as dynamite shells," I added.

"My mind does not follow such conjectures," said the professor, "though I must admit the safe solution of the air ship problem will cause no end of changes and revolutions in every phase of human life."—*London Daily Graphic.*

[NATURE.]

EXPERIMENTS ON FLYING.

IF we imagine the linear dimensions of a bird increased n times, its weight will be increased n^3 times. On the other hand, the work necessary to keep it flying will, as Helmholtz has shown, increase n^7 times.* Now, we can assume that the power, that is to say, the amount of work that can be done in the unit of time, increases in proportion to the weight, or even less. Helmholtz, therefore, concluded that large dimensions are a disadvantage, and that there is a limit beyond which the power will become inadequate to the increased weight. This limit, in his opinion, is already attained in the largest birds, whose bodies appear to be constructed with the utmost economy in weight, and whose constitution and food seem adapted to furnish the highest power. And he therefore thought it improbable that man would ever be able to fly by his own power.

To these discouraging observations, however, some objections may be raised. First, the work necessary to keep a bird flying horizontally depends largely on its horizontal velocity. It decreases with increasing velocity up to a certain limit, when, on account of the friction, too much work must be spent on the horizontal component of the movement. The air will carry a body moving horizontally better than a stationary one, for the same reason that thin ice will sometimes carry a skater, but break under his dead weight. The moving skater is carried as if he rested on long skates that spread his pressure over a large area. The work which is expended in flying horizontally with a sufficiently high velocity may, in spite of Helmholtz's observations, be quite within the reach of human power. The difficulty, then, would only be to start and to arrive at this velocity, and this difficulty might be met by special contrivances. The size of a flier might therefore be increased many times without losing the possibility of quick horizontal flight, though birds must be able to do without such contrivances for starting and arriving at the necessary velocity.

A second objection is that we see many birds—and especially the large birds—when soaring, evidently doing an extremely small amount of work, or none at all, but nevertheless moving rapidly, and even rising to great heights. It seems certain that the wind must do the work for them. The experiments of O. Lilienthal have shown how this is effected. He has made diagrams of the direction of the wind blowing over a plain, and has found it to be, on the average, three degrees upward.* His idea is that the lower regions of the air are retarded by friction against the earth, and that it is therefore heaped up. Of course the rising air or an equal amount would have to come down again somewhere, and this might take place in calm weather. But, however this may be, the wind in some way or other does the necessary work for soaring birds. With a bird of linear dimensions increased n times, this work, it is true, would only increase in proportion to the surface of the wings, that is, proportional to n^2, while the weight increases proportional to n^3. But for man there would be no difficulty in constructing the wing surface much larger in comparison than that of a bird.

The principal difficulty would lie in the management of the apparatus, in keeping the surface in the right position according to the variations of the wind, and according to the direction that one intends to follow. Perhaps it is not greater than the difficulty a skater meets with in keeping his balance while moving in the direction he pleases; but the consequences of a wrong movement are worse. O. Lilienthal seems to me to have made a step in the right direction by trying to learn soaring.† The accompanying illustrations, which are reproductions of instantaneous photographs taken in Steglitz, near Berlin, show the way he slides down a slight decline of 10° or 15°. The shape of the wings is not flat, but slightly curved. The experiments recorded in his book, "Der Vogelflug," show that the curved form has decided advantages, both as regards the amount and the direction of the resistance. The wing surface is 15 square meters. It is not safe to take a larger surface before having learned to manage a smaller one. He takes a sharp run of four or five steps against the wind, jumps into the air, and slides down over a distance of about 250 meters. By shifting his center of gravity relatively to the center of resistance he can give the wing surface any inclination, and thereby can, to a certain extent, either slide down quicker, or slacken the movement, or alter the direction. If the wind is not too strong, and the surface of the apparatus not too large, I think there is very little danger in this kind of practice. If it is taken up by a great many people, improvements of the apparatus are sure to follow, and the art of keeping one's balance in the air will be developed. Perhaps this is the road to flying. At any rate it must be fine sport.

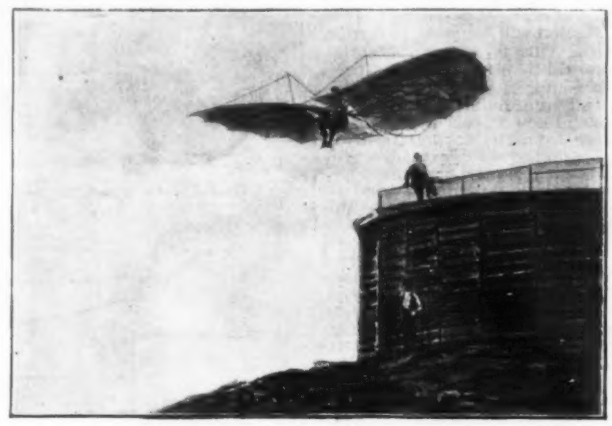


FIG. 3.

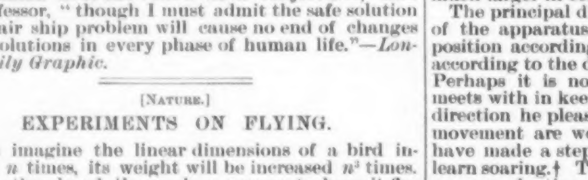


FIG. 1.

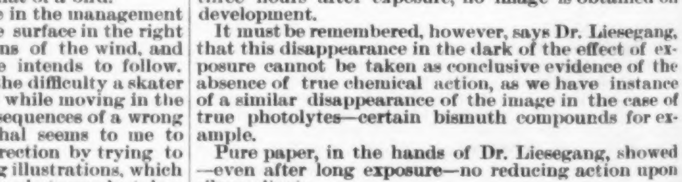


FIG. 2.

* Helmholtz, *Gesammelte Abhandlungen*, bd. I., p. 165.

* O. Lilienthal, "Der Vogelflug," p. 115; see also No. 55 of *Prometheus*, p. 37.

† See his article in Nos. 204 and 205 of *Prometheus*, from which the illustrations are taken.

ALUM AS A SENSITIZING MATERIAL FOR PAPER.

IN the current issue of the *Archiv* Dr. R. Ed. Liesegang details some results he has obtained as an outcome of a study of the so called Niepce phenomena, where the phosphorescence of paper has been believed to bring about various photo-chemical reactions.

In one of Dr. Liesegang's experiments paper was impregnated with potash alum, and by an exposure of three minutes to sunlight such a change took place that those parts of the paper upon which light had acted were able to slightly reduce nitrate of silver; but by a further treatment with gallic acid these exposed parts became quite black, the unexposed parts remaining nearly white.

Paper treated with oxalate of soda, sulphite of soda, arsenite of soda, and several other alkaline compounds showed a similar sensitiveness; while exposures on paper treated with nickel chloride, several organic acids, and sulphate of hydroxylamine gave full brown images on development with silver nitrate and gallic acid, the unexposed parts remaining quite white in these cases.

Liesegang thinks it probable that in the cases just mentioned—the alum, for example—no true chemical decomposition takes place under the immediate action of light, but that light is stored in the prepared paper by a kind of phosphorescence. This view is supported by his observation that the impression of the light is only good for a short period; so that if paper prepared with alum or sulphite of soda is kept in the dark for three hours after exposure, no image is obtained on development.

It must be remembered, however, says Dr. Liesegang, that this disappearance in the dark of the effect of exposure cannot be taken as conclusive evidence of the absence of true chemical action, as we have instance of a similar disappearance of the image in the case of true photolytes—certain bismuth compounds for example.

Pure paper, in the hands of Dr. Liesegang, showed—even after long exposure—no reducing action upon silver nitrate.

When paper is prepared with a solution of sodium nitrate and exposed, an image is obtained on treatment with silver nitrate, followed by gallic acid; the nitrite being oxidized in this case to nitrate where the light has acted.

As bearing on this reaction, Liesegang cites the experiments of Laurent published in 1891, which show an action of light the reverse of that now mentioned. Laurent exposed a sterilized solution of pure potassium nitrate to sunlight, and, after several days, he traced the presence of nitrite in the solution; while samples of a similar solution which had been kept in the dark showed no reaction of nitrite. In a subsequent experiment he found 4·1 cubic centimeters of oxygen were liberated in one particular flask of the nitrite when exposed to light for two months.—*Photo. Work.*

SOME OF THE ANCIENT USES OF ASPHALTUM BY THE ABORIGINES OF CALIFORNIA.

ASPHALTUM was called chapopote by the Indians before the Spaniards entered California. This is the name also used in Mexico.

It was customary with the aborigines of California to bury with their dead the implements and utensils used by them during their lives.

From the customs of to-day and from exhumations made in ancient burial places, the following described uses of asphalt by the Indians have been observed.

A basket without a bottom, made of closely woven grass, was cemented to a flat stone with asphaltum, as shown in Fig. 4. This was employed as a mortar. The Indians gathered acorns, hulled them, and then placed them in a bowl-shaped excavation in the ground. By the aid of water the tannin in the acorn was dissolved and removed by the water slowly percolating into the earth. The acorns were then dried and ground into flour in these mortars with a stone pestle, and, like the practice of to-day, made into a dough and baked.

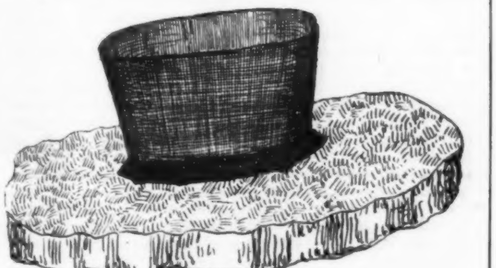


Fig 4

Baskets made of grass were made water tight by a coating of asphaltum. The asphaltum, together with hot stones, was placed in the basket and the basket was turned and caused to oscillate until an even coating was formed.

Baskets were made of tule in the form shown in Fig. 5. The tules were quilted with tarred fiber, asphaltum, with hot stones, was placed in the interior of the basket, and the basket rolled and turned until an interior coating was secured. These baskets were used for water jars.

Mortars were frequently hewn from solid sandstone. These were often accidentally broken and their repair was effected by sticking their fragments together with asphaltic cement, Fig. 10.

Fig 5

DETAILS OF BOAT CONSTRUCTION.

Tules were firmly and closely tied with fiber taken from different plants and tarred with asphaltum into bundles about four inches in diameter in the center and tapering to a point at the ends, and of the length of the intended boat.

Pliant sticks, which were intended to act as the ribs of the boat, were shoved through the bundles at intervals in the manner indicated in Figs. 1 and 2. After a sufficient number of bundles of tules and pliant sticks were placed together, they were bent and secured in the form of the main body of the boat. The bow and stern of the boat were then made in the form and manner shown in Figs. 1 and 3. The tules were then quilted with the tarred fiber until they were firm and watertight, B B B, in Figs. 1 and 3. The bent position of the ribs was maintained by seats. Further rigidity was given to the boat, if necessary, by fastening poles lengthways of the boat to the ribs. The outside of the boat was then smeared with liquid asphalt of the consistency of heavy tar, A A, Fig. 3.

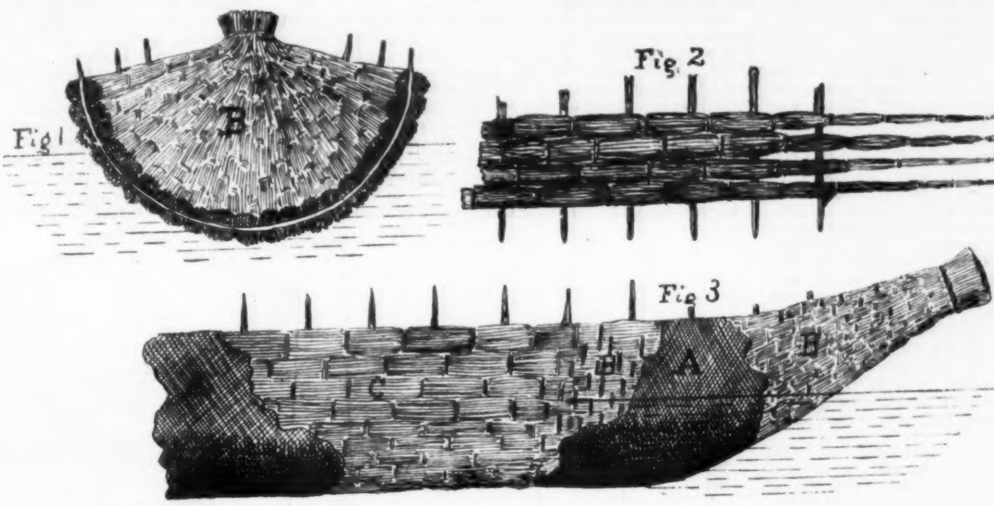


Fig 1 Fig 2 Fig 3

This tar rises in the ocean and floats to the shore in the right state for this use. The surface of the asphalt was rubbed with dry powdered clay to remove its stickiness.

These boats, though cumbersome in appearance, were very light, the main weight being the asphaltum and ribs.

Fig 6

Excursions were made in these boats to the islands, twenty-five miles distant from the mainland. Asphaltum was taken to these islands, where none exists, and steatite, from which their cooking utensils were constructed, was brought back. No steatite exists on the mainland, notwithstanding that it was in common use. These boats were also used for hunting and fishing.

Some of their fish hooks were made from sea lion teeth, Fig. 8. The tooth was notched, as shown in the figure, and bound to a piece of wood with sinew or gut. The sinew or gut was then coated with asphaltum, so that the water would not reach the sinew or gut and cause it to stretch.

The obsidian arrow heads and feathers were fastened to their arrows with sinew or gut, and protected from the action of moisture by asphaltum, Fig. 7. Spear heads were also fastened in this manner. These arrows and spears were poisoned in the following manner: A rattlesnake was provoked so that it would bite a deer's liver. The poisoned liver was then placed in the sun until it became green and putrid. The arrows and spears were then dipped into this corrupted mass. This poison only acts when taken into the circulation of the blood, and, therefore, it did not injure the meat for eating.

Fig 7

Fig 8

Knife blades of obsidian were attached to wooden handles with asphaltum, Fig. 6. These knives were used for skinning animals.

Stems of pipes were fastened to serpentine bowls with a mixture of clay and asphaltum, Fig. 9.

Heads were made on wooden and bone pins with asphaltum, Fig. 11.

Asphaltum was stored and transported in bivalvular shells, like the clam and mussel.

The length of the column of air in their whistles, which were manufactured from a hollow bone taken from a pelican's wing, was regulated by an asphalt plug.

When the wood which they used for fuel was wet by winter rains, it was dipped into asphalt tar springs to make it more combustible. Indian cooking utensils are found in the neighborhood of all bituminous springs.

These tar springs were the fire works of the Indian boys. When set on fire, huge convoluted columns of dense black smoke were seen by day, and the brightness of their flame by night. All of these springs are coked by repeated fires.

Fig 9

Fig 11

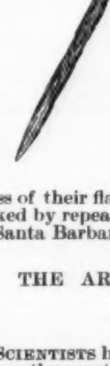


Fig 10

Santa Barbara, Cal., January 4, 1894.

THE ARTIFICIAL PRODUCTION OF PETROLEUM.

By Dr. C. ENGLER.

SCIENTISTS have discussed very often in the last few years the question in which way petroleum, this source of wealth, with its special scientific interest for America, was formed by nature. According to one theory, it is generated from inorganic materials. Sokoloff thinks that petroleum was produced during the period of the formation of our planet out of cosmical hydrocarbons which, in the beginning dissolved in the soft mass, separated from it later on. Mendelejeff assumes that water entering by fissures and chasms the interior of the earth came in contact with melting carbide of iron and produced so in a simple manner oxide of iron and the hydrocarbons of petroleum. Strong objection cannot be made to these two theories from the chemical standpoint; but the composition of the different kinds of petroleum is against them, and geology considers them not free from objections.

For a series of years the idea that petroleum was produced from the remains of plants by a kind of distillation process was most generally adopted, especially by chemists. Chemical and geological reasons are against this theory. From the chemical standpoint it seems quite impossible that the substance of the plants could be split up by distillation into petroleum without leaving charcoal or coke. There would also be a genetic connection between coal and petroleum; but in occurrences of the ordinary kind, coal is nearly always absent. If this were really the case, then there ought to be with every oil occurrence in close connection a coal bank, which really seldom happens.

By a third theory the remains of animals form the raw material from which petroleum is formed in nature. There are many facts proving the decay of masses of animals which we find now in banks in the crust of the earth in the form of the remains of shells, fishes, saurians, etc. Prominent scientists, among them the Americans Wrigley, Whitney, Hunt, and others, and in Europe Hofer and Ochsenius, especially defend this

idea on geological grounds. But I will not enter into the geological discussion, preferring to try to give an answer to the question: How can the transmutation of animal remains into oil be imagined?

In order to answer this some thousands of salt water fishes and also shells have been distilled under strong pressure. The result was a liquid, containing mostly nitrogenous bases, such as pyridin, which was little or not at all similar to petroleum. I then recalled some experiments of Wetherill and Gregory, who found that the wax found in cadavers, the so-called "adipocere," was nothing else but the fatty residue, which remains after the putrefaction of all the other animal matter, especially of the nitrogenous constituents of the cadaver. It is also well known that even fossil bones frequently contain fat. The question now raised was this: Could not the process in nature have been a similar one; should not first of all the nitrogenated animal substance have been destroyed, leaving the fat, which was then transformed into oil? In order to prove chemically this possibility, I submitted animal fat (train oil) to distillation—first in a sealed glass tube, later on in a large iron vessel—under a pressure of twenty-five atmospheres at a moderate heat (300–400° C.), and to my great delight found that under favorable conditions seventy per cent. of the train oil was transformed into petroleum. This equals ninety per cent. of the theoretical output. Besides the oil some water and some combustible gas was always formed. The same behavior has been shown by other fats like butter, the fat of hogs, artificial fats, also the chemically pure glycerids of the fats like tri-olein, tri-stearin and the free fatty acids. All could be transformed into petroleum by distillation under pressure, when managed in the proper way.

I have here a liquid which is the distillate of the fish oil, and I have isolated from it almost all the hydrocarbons which have been discovered in the petroleum of Pennsylvania. The other products—the oil burning in this small lamp, too—are oils obtained from the crude material by purification.

But not only illuminating oils are produced. I separated also by distillation those lighter hydrocarbons which compose the gasoline, the ligroin, the benzine, etc. Recently I have succeeded in finding and separating paraffine wax and lubricating oils from those parts of the crude oil which show a high boiling point. This removes the objection of O. Ross to my theory of the formation of petroleum from animal remains. As a matter of fact, I found in the distillate obtained by decomposition of train oil nearly all the constituents which have been separated from the natural crude petroleum, and even the gases, which, like natural gas, consist essentially of marsh gas.

Very recently I have made close investigations on the mechanism or on the chemism of the formation of the hydrocarbons of the petroleum produced by distillation of fat under pressure. These experiments prove that the simpler organic acids split up in the same way, yielding almost the theoretical quantity of the respective hydrocarbon. Thus phenylacetic acid yields toluene. For further details I am obliged to refer you to the actual experiments. I need only remark that we have to assume that the acids with high molecular weights are decomposed with the production of a number of hydrocarbons.

To recapitulate, it is a geological fact that we find in nature the remains of antediluvian animals, as shells, fishes, saurians accumulated in masses. Whether these animals have been piled up in consequence of a natural super-production in special places in the ocean, or by currents, or in consequence of great revolutions of the earth, this must be decided by geology; but the remains exist.

Now in which manner do the organic substances of these animals become decomposed?

The animal substance consists essentially of nitrogenated material and fat. The former is easily decomposed, the latter is very stable—a fact which has been very well known for a long time, and has been shown again by exact investigations. Therefore we find the wax of cadavers in old graves, therefore the fat in the bones of mammals thousands of years old, therefore the fat on the bottom of the ocean recently found.

Whether and how far the fat was decomposed in this long period by the water splitting up glycerol and forming the free acid, for instance, the fat in the bones of mammals, cannot be answered. Both fat as well as the fatty acids form petroleum, when distilled under pressure.

We can imagine that such remains wrapped in mud and transported by the currents in the ocean easily accumulate, and later on under the pressure of sedimentary layers or strata, perhaps under the influence of heat, too, are transformed into petroleum. This is only one of the many possibilities by which the mechanical process of the transmutation of fat into petroleum may have happened.

Under any circumstances I think I have proved that from the chemical standpoint, the formation of petroleum from animal remains has the greatest probability, as we are able now to transform every animal fat into petroleum.—*Jour. Amer. Chem. Soc.*

CLOTH OILS IN REGARD TO FIRE RISKS.

By W. McD. MACKEY.

WHEN dealing with distilled oleins, both foreign and distilled from black oil and brown or Yorkshire grease, the chemist is seriously troubled by the mineral oil question, which assumes a fictitious importance owing to the insurance companies' practice of charging a high rate when an oil is classed as containing mineral oil. Thus black oil containing say, for the sake of simplicity, no unsaponifiable matter, may yield on distillation with superheated steam an olein containing a considerable quantity of unsaponifiable hydrocarbon oil, and the amount may be increased by repeated distillation.

Dr. Lewkowitsch found a specimen of Yorkshire grease that he examined to yield, when distilled on the manufacturing scale, 34·54 per cent. of unsaponifiable hydrocarbons.

These hydrocarbons, the result of reduction during the distillation of fatty oils, are liable to be mistaken for added mineral oil. The nature of such hydrocarbons has not been exhaustively studied, but as far as insurance risks are concerned there seems to be little difference between them and mineral oil itself.

As a result of the new departure in insurance rating, the tendency is to depend on the flash point of an oil, the amount of unsaponifiable matter and a certificate of genuineness from the vender. This certificate in the case of recovered oils is usually valueless, as the oil manufacturer has seldom control over the oil finding its way into the seak (spent soap liquor) he buys. Though the flash point test is invaluable, the determination of the unsaponifiable matter gives data of little use as regards fire risk.

The fact that the tests ordinarily applied are inadequate is not owing to the difficulty of finding better, but to the fact that chemists are seldom asked to give their opinion as to the fire risks attending the use of oils submitted to them. The question usually is if the oil will fulfill the conditions of the schedule; and if the examination goes beyond the flash point and determination of unsaponifiable matter, it leads to questions of composition, sometimes incapable of satisfactory answer, and often of no interest whatever as regards actual fire risk.

Hence, also, the oil manufacturer, if he is so disposed, can, as far as insurance interests are concerned, practically sophisticate with impunity in certain directions.

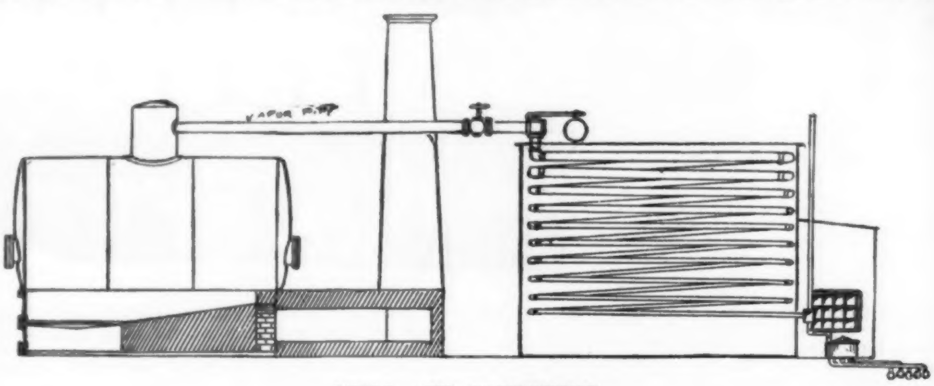
Tests should be insisted on that would indicate the behavior of any particular oil under the conditions obtaining in its use, and there is no doubt that if there were some authority of the nature of Lloyds' in shipping, the testing of oils by rational methods would be undertaken, to the benefit of insurance interests and also those of the cloth and oil trades.—*Chem. Tr. Jour.*

THE REFINING OF PETROLEUM OIL.

IN spite of popular inveighing against monopolies and popular clamor for legislation against trusts, a thoughtful examination of the work and practice of the Standard Oil Company, the representative trust of them all, will show that they are not without their benefit to the public. The removal of what is often a ruinous competition has not only enriched the refineries, but has also cheapened their product to the public. Instead of religiously guarded trade secrets, we find the various superintendents conferring on what are the best methods of pursuing their occupation. Experiments are carried on by a common fund and the results given to all members of the trust, and in this way the best results are obtained at the very least outlay. The general practice of the various refineries is almost identical, excepting that those of more recent construction are a little improved in the mere detail. All dimensions given in this article refer to no particular establishment, but are merely average good practice.

The process of refining consists in the division and redivision of the crude oil into the various components and then purifying and refining the product. The petroleum products naturally divide themselves into three main groups; the light, nearly colorless, and highly volatile benzines and illuminating oils; the heavy more or less deeply colored paraffine oils and wax, and finally the residuary coke. The first are distilled directly from the crude oil, a heavy black "tar" remaining as a residue in the stills. The second are distilled from this "tar" and the coke is left as perfectly dry residue.

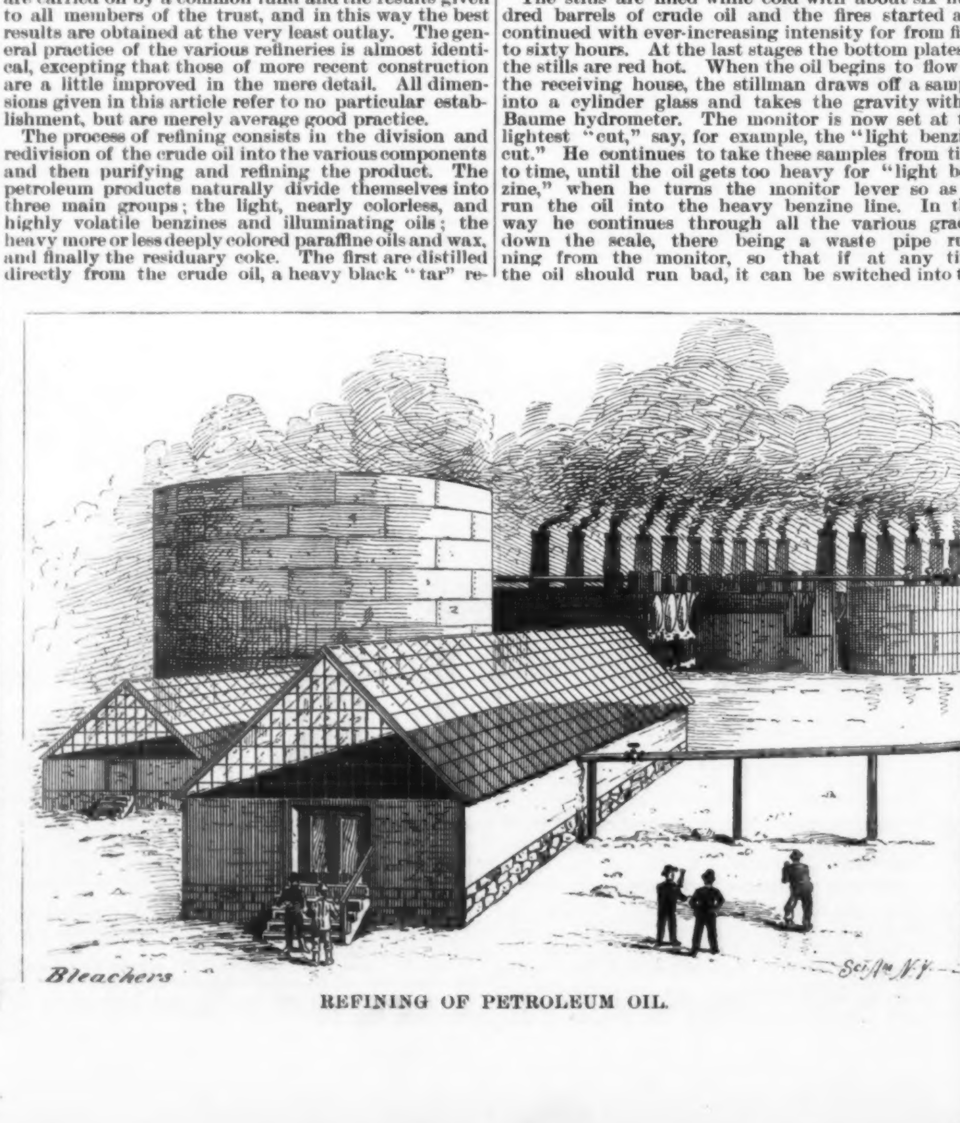
For the first or crude process the apparatus used consists of a still, a condenser and a receiving house, with its accompanying paraphernalia. The crude stills are plain cylindrical vessels 13 feet in diameter and 30 feet long. The condenser tanks are 30 feet in diameter, one tank serving two stills. These are arranged in batteries as shown. The firemen are stationed between the stills, and the stillmen occupy the receiving houses. The stills are of $\frac{3}{8}$ inch riveted steel, plain cylindrical, with dialed heads, surmounted by a dome from which a vapor pipe leads. There is, besides, a filling pipe for crude oil and a tar pipe for pumping off the residue, and a manhole in each head for cleaning and repairing. Either in the top of the dome or at some point on the vapor pipe is a safety valve set to blow at a pound to one and a half pounds pressure. The setting is the simplest possible. There is no return flue. The still rests on brick work built up to the middle, the heating surface being about half the cylindrical area of the still. The upper half is often jacketed with corrugated iron, with about a nine inch air space.



STILL AND CONDENSER.

Each condenser contains two square coils of pipe, one from each of a pair of stills, gradually reducing from the nine inch vapor pipe to the three inch pipe entering the running box in the receiving house. This is a small glass-fronted box, where the flow of the oil and its color can be constantly watched. From this box lead two pipes; one from the top, which carries the gas arising from the oil back to the grate to be burned, and the other from the bottom, which carries the oil to the "monitor." The object of this last apparatus is to distribute the oil into the several lines, whence it flows into the various tanks. The oil flows into a box inside the monitor which can be revolved by a handle, so as to bring a nozzle in the bottom of the box opposite the openings of the various pipe lines placed around the circumference of the bottom of the monitor. These lines are: Light benzine, heavy benzine, water white distillate, standard white distillate, etc., depending upon the number of grades of oil desired.

The stills are filled while cold with about six hundred barrels of crude oil and the fires started and continued with ever-increasing intensity for from fifty to sixty hours. At the last stages the bottom plates of the stills are red hot. When the oil begins to flow in the receiving house, the stillman draws off a sample into a cylinder glass and takes the gravity with a Baume hydrometer. The monitor is now set at the lightest "cut," say, for example, the "light benzine cut." He continues to take these samples from time to time, until the oil gets too heavy for "light benzine," when he turns the monitor lever so as to run the oil into the heavy benzine line. In this way he continues through all the various grades down the scale, there being a waste pipe running from the monitor, so that if at any time the oil should run bad, it can be switched into the



REFINING OF PETROLEUM OIL.

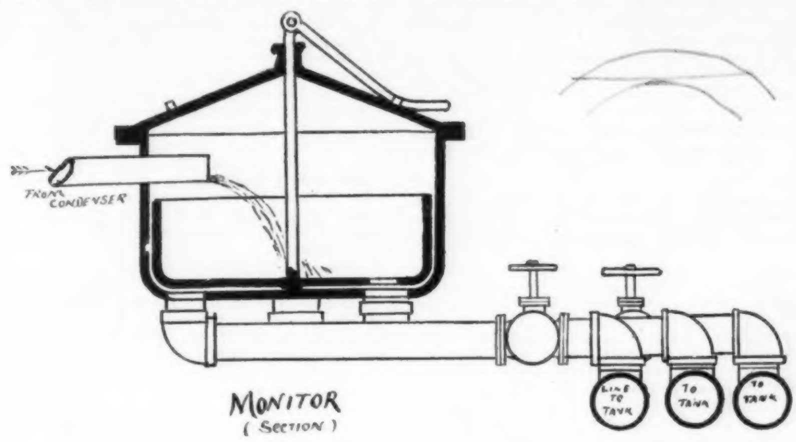
waste tank. After the run is finished the fires are allowed to go out; the residuary "tar" pumped into a large tar tank; the still opened, cleaned, and inspected and made ready for a new run.

The products of this process are still very crude. The oil is not clear and has a foul odor. The first is caused by the presence of paraffine carried over in the process of distilling, which gives the oil a cloudy appearance, and if allowed to remain, would char the wick in burning. The second is caused by the presence of certain light hydrocarbon oils which, besides their unpleasant odor, are objectionable as being highly volatile, and consequently dangerous. These volatile oils are removed in steam stills, large jacketed stills containing about one thousand barrels and traversed by numerous steam pipes. No fire is used under these stills, the vaporization of the light impurities being accomplished by the steam. It is drawn

Of course all these lines will not be yielding at the same time, as at the beginning of the "run" only the lighter oils will be coming off and at the close only the heavier grades, still several grades are condensed simultaneously.

By this process all grades of paraffine oils are made, from the light red oil down to the heavy dark green oil used for only rough lubricating, such as car axles. The residue in the stills from this process is a perfectly dry and very excellent coke, which is clipped out of the still as soon as it is sufficiently cool.

The "chill point" of oil is that temperature at which the paraffine wax "crystallizes" out from the oil. It is by reducing the paraffine oil below the chill point that wax is extracted. A chilling box about eight feet long, six feet square at the front end, and four by six in the rear, with an inclined bottom and movable front, is used. The box is divided into sec-



MONITOR
(SECTION)

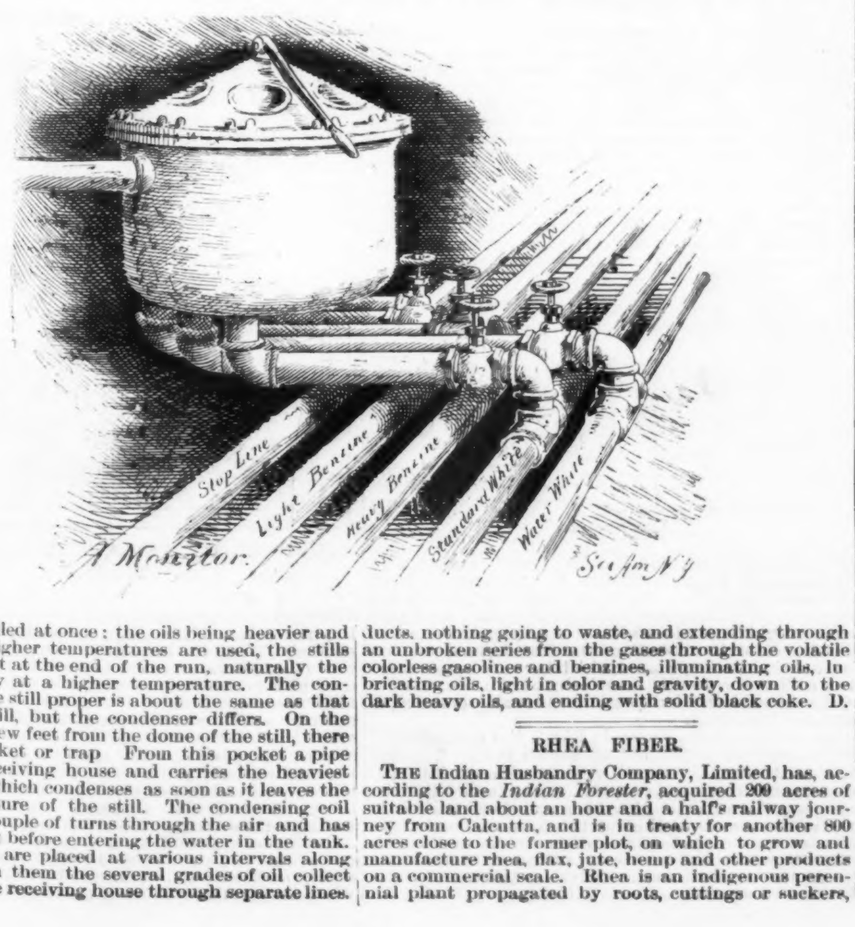
off through a vapor pipe, as in the former process, and condensed and purified is the commercial benzine. The partly purified oil is now pumped from the steam stills into a receiving tank and is ready for the process which removes the paraffine impurities.

This is accomplished in an apparatus called an agitator. This is a tank about ten feet diameter, with a funnel-shaped bottom, and fitted with three pipe lines, one for oil, one for sulphuric acid, and the third for water. The oil is pumped into the agitator, sulphuric acid is added, and the whole thing "agitated" by blowing air up through it by means of a small blowing engine. The acid acts as a solvent on the paraffine, and, on stopping the blowing, settles to the bottom, dragging down the impurities in solution. There is no difficulty separating the oil and acid, as, after settling, the latter is easily drawn off through the funnel-shaped bottom with no material waste of oil. Water is now added and the mixture again agitated to wash out the residuary acid, the contents drawn off into settling tanks and thence into the final receiving tanks, whence it is sold as a finished product under the various names of gasoline, naphtha, headlight oil, astral oil, water white, standard white, ship oil, etc., depending on the gravity, flash, fire and color tests and on the place of manufacture.

The paraffine oils and wax are extracted from the "tar" residue of the crude stills by a process differing only in detail from that of extracting the lighter oils from the crude. The stills are smaller and the monitor not used; instead of one grade at a time, several grades

tions by twelve iron partitions, through which brine, chilled by the ordinary form of ammonia refrigerating plant, is circulated. The oil is pumped into these boxes and the brine is circulated until the oil becomes thoroughly "chilled," it is then of the consistency of, and exactly resembles, vaseline. The front of the box is now removed and these immense slabs of vaseline-like substance are slid out and fall into a hopper, at the mouth of which are rapidly revolving knives which cut up the slabs into small bits. From the knives the chilled paraffine is inclosed in canvas and placed in a hydraulic press, where, under a pressure of about two thousand pounds per square inch, the oil is pressed through the canvas and the wax remains. The wax that comes from the canvas bags is hard, firm, brittle and of a light yellow color. This, after being decolorized, is made up into the familiar paraffine candles and other countless uses for which it is fitted, perhaps even including chewing gum.

The oil that comes from the paraffine press is a very fine light lubricating oil, used for light-running machinery, such as that of a spinning mill. Paraffine oils are not purified in the same way as are the illuminating oils; the only process they are put through is that of bleaching. The bleachers are houses closely resembling greenhouses. They consist in a shallow tank surmounted by a gable-ended glass roof. Here the oil is agitated by a constant flow of steam and the bleaching action of the sun does the rest. In this way from the crude oil is obtained this remarkable range of pro-



A Monitor.

of oil are distilled at once: the oils being heavier and less volatile, higher temperatures are used, the stills being white hot at the end of the run, naturally the oils also liquefy at a higher temperature. The construction of the still proper is about the same as that of the crude still, but the condenser differs. On the vapor pipe, a few feet from the dome of the still, there is an iron pocket or trap From this pocket a pipe leads to the receiving house and carries the heaviest grade of oil, which condenses as soon as it leaves the high temperature of the still. The condensing coil then takes a couple of turns through the air and has another pocket before entering the water in the tank. These pockets are placed at various intervals along the coil, and in them the several grades of oil collect and flow to the receiving house through separate lines.

ducts, nothing going to waste, and extending through an unbroken series from the gases through the volatile colorless gasolines and benzines, illuminating oils, lubricating oils, light in color and gravity, down to the dark heavy oils, and ending with solid black coke. D.

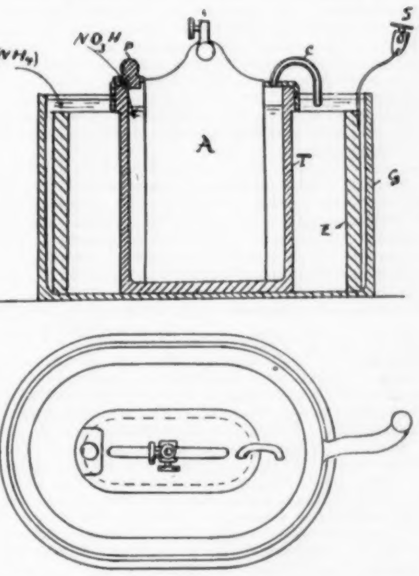
RHEA FIBER.

THE Indian Husbandry Company, Limited, has, according to the *Indian Forester*, acquired 209 acres of suitable land about an hour and a half's railway journey from Calcutta, and is in treaty for another 800 acres close to the former plot, on which to grow and manufacture rhea, flax, jute, hemp and other products on a commercial scale. Rhea is an indigenous perennial plant propagated by roots, cuttings or suckers, and yields in some places five crops in a year. Its fiber is placed in a pre-eminent position by its inherent physical properties: fineness, length, luster, strength, lightness, durability, and resistance to water, and which favor its application to various textile fabrics. It is already being converted in Europe into imitation silk fabrics, handkerchiefs, neckerchiefs, ladies' scarfs, umbrella and parasol covers, waistcloth, etc., etc. It stands a strong rival to the finest varieties of flax, and in canvas and sail cloth its superiority over flax is undoubted. It admits of advantageous admixture with wool as well as silk, and the "noils" or the waste of the fiber, when cut into lengths of two inches and mixed with cotton in the willow machine, render the yarn stronger and shining. Mr. J. Cameron, superintendent, Botanical Gardens, Bangalore, states that he has been selling rhea rooots at a nominal charge of R25 per 1,000, and that he still has several thousands in stock, and could easily increase the nursery stock enormously. The chief interest taken so far in the extraction of rhea or ramie fiber from *Boehmeria Nivea* has been centered at Belfast. It is stated that the Bank of France recently had a new issue of notes printed on paper made of this fiber.

ALUMINUM BATTERY.

MY object in introducing this battery, the most powerful of all I have devised, is that I want to give to electrical amateurs and experimenters a galvanic battery by which they, in a cheap and practical way, get in possession of a very powerful and handy source of electricity of very constant current. Here I will mention that concerning its application to electric light I can give a clear proof that even the most perfect galvanic battery will always be much more expensive for electric light than a small dynamo driven by steam or gas. The battery was tested when it had its original shape, for which I obtained a patent. Before I am going to describe it as it is in its new and greatly improved shape, I will give the results of this test, because that involves the principle and is the base for its later design as an aluminum battery.

The tested battery was of cylindrical shape, and of



rather small dimensions. It consisted of a glass 3 in. external height and 2⅜ in. external diameter. Within the glass was a zinc cylinder immersed in a saturated solution of sal ammoniac. Within the zinc cylinder was a porous jar. Its external height was 2½ in. and its external diameter 1⅝ in. In this porous jar was a big piece of carbon and nitric acid. The top of the carbon was paraffined. The soldering on the zinc cylinder was protected.

THE TEST.

It had an electromotoric force = 1·9 volt and an internal resistance of 0·25 ohm when new, that is before it gave off any current. That is a very little resistance, considering the small dimensions of the battery. Connected to an external resistance of 3·7 ohms, the e.m.f. was 1·75 volts at the end points of the resistance; consequently the electric current was

$$\frac{1{\cdot}75}{3{\cdot}7 + 0{\cdot}25} = 0{\cdot}443 \text{ ampere.}$$

At the elapse of 35 minutes the e.m.f. was 1·7 volt and the internal resistance of the battery was 0·24 ohm; therefore, the current was

$$\frac{1{\cdot}7}{3{\cdot}7 + 0{\cdot}24} = 0{\cdot}432 \text{ ampere.}$$

At the elapse of 40 minutes more [altogether 75 minutes] the results were: e.m.f. = 1·66 volt; inner resistance = 0·22 ohm, and current = 0·423 ampere.

At the end of 30 minutes more [altogether 105 minutes] the results were as follows: e.m.f. = 1·6 volts, inner resistance = 0·25 ohm, and current =

$$\frac{1{\cdot}6}{3{\cdot}7 + 0{\cdot}25} = 0{\cdot}405 \text{ ampere.}$$

We see of that, that by the work given off hitherto the inner resistance had not at all increased. On the contrary, it decreased a little, which must be due to a slight rise of temperature in the liquids. The battery was now connected to a resistance of such a size that it gave off a current = 1 ampere. By that the e.m.f. dropped to 1·5 volts; the internal resistance being unaltered. The battery endured that through 1 hour without getting its e.m.f. lower than 1·45 volts, and its internal resistance rose only to 0·255 ohm. Now the battery had given off about 1¾ ampere hour with an average voltage of 1·6 volts. At the beginning of the tests the weight of the zinc

was 0·222 lb. At the end of the tests the weight of the zinc was 0·217 lb.; consequently, the loss of zinc was 0·005 lb. The theoretical loss of zinc should be ca. 0·0047 lb., which shows that the battery presents but very little local action. Having rested ca. 1 hour, the e.m.f. had risen to 1·82 volts. The inner resistance was 0·31 ohm. Connected to an external resistance of 7 ohms, then the e.m.f. was 1·66 volts at the elapse of 10 minutes. It worked then during 15 hours, and at the end of this time the e.m.f. was 0·23 volt, and the inner resistance was 3 ohms. Then it rested 2 hours and the e.m.f. rose to 0·73 volt, its inner resistance sank to 2 ohms. After 1½ hours rest the e.m.f. was 1·16 volts; resistance = 2 ohms. Here ended the tests. The weight of the zinc cylinder was now 0·211 lb., which shows a very small amount of zinc consumed compared with the great electric work given off. The weight of zinc consumed was only 0·011 lb. It shows that the "local action" on the zinc is very small. That is not the case by the Bunsen battery or the well-known bichromate battery. Besides, those batteries will soon be exhausted.

It has to be remarked following:

1. During the test the nitric acid was not protected from being in contact with the air; therefore the nitric acid (NO_3H) was quickly losing its available oxygen by exposure to the air, and it was too soon reduced to nitrous acid (NO_2H).

2. There was diffusion between the two liquids. It could have been prevented by having the level of the nitric acid to be about 1 in. above the level of the sal ammoniac solution.

3. At the end of the test the battery showed the remarkable feature that the level of the nitric acid had sunk a little, while the level of the solution of sal ammoniac had risen a little. This phenomenon is due to the formation of water in the sal ammoniac and effected by the electro-chemical action.

4. But the most important phenomenon was the development of hydrogen in the terra-cotta pot. The hydrogen bubbled up through the acid with increasing force the longer time the battery had worked. When the nitric acid was nearly transformed to nitrous acid then the development of hydrogen was so violent that, by close examination, the top of the pot was like a small fountain, small particles of acid being thrown up in the air in all directions. If I put a lit match to the surface of the nitric acid, then a cracking noise was heard, due to the small explosions of the hydrogen.

5. It must also be remarked that, due to the great difference of potential between zinc and carbon, hydrogen will stick to the carbon with the effect of decreasing the potential difference and of increasing the internal resistance.

Due to the phenomenon that hydrogen is developed in the nitric acid, and that the electro-chemical formation of water takes place in the solution of sal ammoniac, I concluded that the carbon was only a conductor for the nitric acid, which has to be considered as the electro-positive pole, and the zinc is the electro-negative pole. Therefore, I replaced the carbon by a rod or plate of aluminum.

The aluminum battery, as it is shown in the figure, consists of a glass filled with a saturated solution of sal ammoniac, in which is immersed a cylinder of zinc or of aluminum; in the glass is also put plenty of undissolved sal ammoniac, which will be dissolved by and by, when the electro-chemical action is going on, due to the formation of water and due to the rise of temperature in the liquids. Within the sal ammoniac is the porous jar filled with nitric acid, and containing the aluminum plate. The level of the nitric acid is about 1 in. above the level of the sal ammoniac. The top of the pot is closed by a rubber cover, which extends a little below the surface of the sal ammoniac. From this cover is a rubber tube, the one end of which dips into the sal ammoniac. This small tube allows the hydrogen to escape from the jar, and together with the rubber cover it prevents the air coming into contact with the nitric acid. In the lid is also shown a plug of glass or porcelain. By removing this we can renew the nitric acid.

NO_3H	means	nitric acid.
$Cl(NH_4)$	"	sal ammoniac.
A	"	an aluminum plate.
G	"	the glass.
T	"	the porous jar.
P	"	the plug in the lid.
C	"	the small tube through which the hydrogen can escape.
Z	"	the zinc or the aluminum cylinder.
S	"	the battery screws.

With zinc cylinder the aluminum battery gives fully two volts. This voltage it keeps surprisingly constant. That is also the case about the current.

There is but little difference of potential between zinc and aluminum, and aluminum does not get attached by nitric acid at a temperature below the boiling point. This is the same phenomenon which happens, for instance, by concentrated sulphuric acid and silver. At ordinary temperature silver is not attacked by sulphuric acid, but when immersed into concentrated sulphuric acid at boiling temperature, then it is dissolved. Therefore care must be taken that the battery does not become hot.

The zinc cylinder can be replaced by an aluminum cylinder; in this case the voltage is 1·8 volts. Neither the zinc nor the aluminum cylinder is consumed by the sal ammoniac for open circuit, but as soon as the current is set up the chemical action starts.

Aluminum is getting cheaper every year. It will soon be cheaper than zinc with regard to volume. It is one of the lightest metals known, its weight being only 2½ times the weight of water. The weight of zinc is ca. 7·3 times that of water. From that we see that for the same weight the volume of aluminum is about three times the volume of zinc. This fact reduces indirectly the cost of aluminum when used for galvanic batteries. We remember that metals are sold by weight. Next there is another economy by using aluminum instead of zinc. In the chemical action of the battery we get evolved two molecules of hydrogen for each molecule zinc consumed, but we get developed three molecules of hydrogen for each molecule aluminum consumed. That means that, for same amount of electric work given off by the battery, we spend more zinc than aluminum, the ratio being as 3 : 2. We see by the facts given above that the aluminum battery has the highest voltage, the most constant current, the smallest and most constant internal resistance. No other battery of constant current is to that extent economizing with the zinc and the liquids as the aluminum battery.

The aluminum battery is particularly to be recommended for electrical industry on a small scale, due to the cheapness of the first cost and its handiness, which again is due to its great and enduring power.

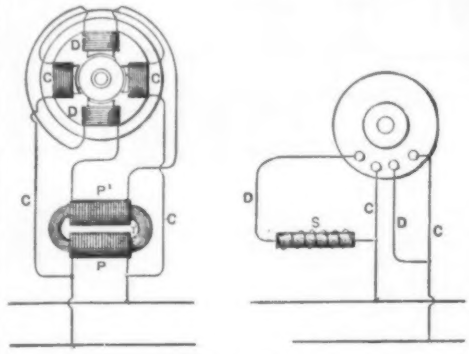
The aluminum battery is particularly to be recommended in all cases where a battery is wanted to overcome hard work.

Applications of this battery will be to electroplating, to telephonic work, to electric boats, to electric fan motors, etc. It can also be used for telegraphic work, but here I should recommend the use of a small dynamo driven by gas or steam or water power. The aluminum battery can be constructed very light and powerful and occupying a small floor space. Due to these facts, it may perhaps solve the problem of the electrical source for an electric flying machine.

To my friends the electric experimenters, and to the electric amateurs, I know that I have now given in hand a gem of a battery. KNUD BENTZEN.

TESLA MOTORS OPERATED FROM SINGLE-PHASE TWO-WIRE ALTERNATING CIRCUITS.

THOSE who have followed Mr. Tesla's work in alternating motors will recall that in 1888 he first drew public attention to his new multiphase system of ope-



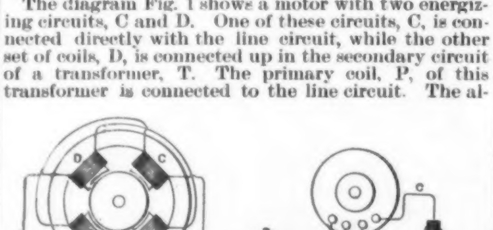
FIGS. 1 AND 2.

rating alternating current motors, in a paper read before the American Institute of Electrical Engineers, in which he laid down the principles which have since been practically applied in many ways. In this system, it will be remembered, each motor contains two or more independent energizing circuits through which are passed alternating currents, having in each circuit such a difference of phase that by their combined or resultant action they produce a rotary progression of the poles or points of maximum magnetic effect of the motor and thereby maintain the rotation of the armature.

A multiphase system of this kind, however, requires at least three wires for its successful operation, to convey the currents differing in phase, and Mr. Tesla, therefore, early set about to devise means for operating phase motors from the ordinary single phase alternating circuit, by creating the difference of phase locally at and in the motor. The various ways in which this can be done are described in two patents just granted to Mr. Tesla, which are of special interest at this time.

In all the methods described below the fundamental idea involved is to pass a single alternating current through both of the energizing circuits of the motor, and to retard the phase of the current in one circuit to a greater or less extent than in the other. The distribution of current between the two motor circuits is effected either by induction or by derivation.

The diagram Fig. 1 shows a motor with two energizing circuits, C and D. One of these circuits, C, is connected directly with the line circuit, while the other set of coils, D, is connected up in the secondary circuit of a transformer, T. The primary coil, P, of this transformer is connected to the line circuit. The al-



FIGS. 3 AND 4.

ternations of current in the line tend to establish in their passage through the coils, C, a polarity opposed to that set up in the coils, D, and if the currents in the two sets of coils coincided in their phases, no rotary effect would be produced. But the secondary current developed in the coil, P, of the transformer, will lag behind that in the primary, which lag may be increased to a sufficient extent to practically obtain the same result as though two independent currents were used to energize the motor.

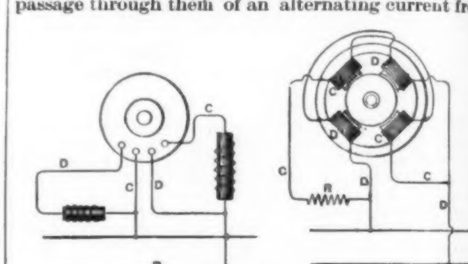
In another form, shown in Fig. 2, the arrangement of the parts is similar to that shown in Fig. 6, except that a self-induction coil, S, is introduced into one energizing circuit of the motor. The effect of thus increasing the self-induction in one of the circuits is to retard the phases of the current passing therein to a greater extent than in the other circuit, and in this way to secure the necessary difference in phase between the two energizing currents to produce the rotation of the motor.

In Fig. 3 there is shown diagrammatically a type of motor in which two dead resistances, R R', are included respectively in the energizing coils of the motor. No rotary effect will be produced as long as the resistances are equal, but by varying the resistance in one circuit the retardation of the current in that circuit will be varied and corresponding effects produced. For example, a reduction of the resistance in one circuit imparts to the motor rotation in one direction, while a reduction of the resistance in the other circuit will produce a rotation in the opposite direction. By means of the two resistances, therefore, capable of variation or of being bodily withdrawn from or inserted in the circuits by simple means, rotation of the motor is secured.

In Fig. 4 a self-induction coil, S, is included in one of the motor circuits and a dead resistance, R, in the other. The increased self-induction in one circuit thus produced acts to increase the difference of phase between the current in that motor circuit and the unretarded current in the line circuit. On the other hand, the introduction of the dead resistance in the other motor circuit reduces the retardation and brings the phases of the current in it more closely in accord with those of the unretarded current, thus producing a correspondingly greater difference of phase between the two currents in the energizing circuits, C and D.

In Fig. 5, two self-induction coils are shown, one in each motor or energizing circuit. One of these coils is much smaller than the other and has less self-induction or counter E. M. F. than the other, so that the phases of current will be retarded to a less extent than in the other.

In Fig. 6 the two energizing circuits of the motor are shown connected in multiple arc to the line circuit, and in one of these circuits is a resistance, R. Assuming the two motor circuits to have the same degree of self-induction, no rotary effect will be produced by the passage through them of an alternating current from



FIGS. 5 AND 6.

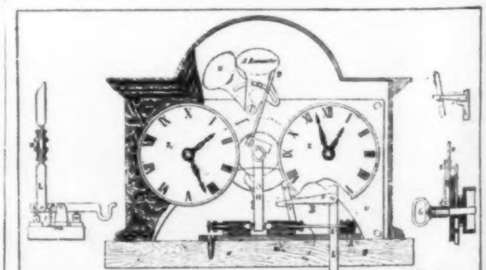
the line. But if one of the motor circuits, as C, be varied or modified by the introduction of a dead resistance, R, the self-induction of that circuit or branch is reduced, and the phases of current therein retarded to a correspondingly less extent. The relative degrees of retardation of the phases of the current in the two motor circuits with respect to those of the unretarded current in the circuit, B, thus produced, will set up a rotation of the motor.

Finally we may mention another type in which one set of energizing coils is of finer wire than the other or has a greater number of convolutions, or each circuit may contain the same number of convolutions, but composed of different conductors, as, for instance, one of copper, and the other of German silver.

Mr. Tesla has devised still other methods for accomplishing the same purpose, but those described will give a fair idea of the wonderful flexibility of the system.—*Electrical Engineer.*

COUNTER OF TELEPHONE COMMUNICATIONS.

IN certain cities of Europe and America telephone subscribers do not pay a fixed rate of subscription per year, but the charge made by the administration is proportional to the real time during which the telephone is in use. To this effect, there have been established, especially in England, counters that indicate the time in question. The duration of each communication is first registered by the apparatus and afterward all the periods are totalized. This apparatus consists essentially of a clock and an escapement and



COUNTER OF TELEPHONE COMMUNICATIONS.

disengaging arrangement, which is set in motion when the transmitter of the telephone is unhooked and suspended. When the clockwork movement has reached the end of its travel, the subscriber is notified of it by a visible sign, and the telephone cannot be used until after the clock has been wound up. The apparatus operates as follows: The commutator embraces an interior lever, A (figure to the left), upon which is fixed a controlling rod, L, whose length may be exactly regulated by means of the nut, M. This rod traverses the cover, D, of the telephone box and enters the case of the clock, U (central figure). The free upper extremity of the rod, L, carries a hook, F, of extreme mobility, which rests upon a fixed pin, S. The left end of this hook possesses a form such that a pin, s, of the pendulum rod, P, effects the lifting of the hook when the pendulum is at the end of its swing, while

the telephone transmitter is suspended, and holds the pendulum rod and stops the clock.

In the upper figure to the right is represented a modified form of the extremity of the rod, L. In this arrangement the pin, S, is replaced by the support, *a*.

At the moment that the transmitter is unhooked and it is desired to use the telephone, the lever, A, is attracted toward the base by the spiral spring, *f*, so that this lever touches the contact, *t*, of the telephone conductor.

Consequently the rod, L, lowers with the hook, E, whose left extremity places itself in the position shown by the dotted line (central figure); the pendulum rod becomes free and the clock begins running.

The motion of the clock is transmitted to the dial, *z*, in the ordinary way, so that one can read thereon the hours and the minutes during which the telephone has been in use. In order to make it possible to register more than twelve hours, one or more dials, z^1, are added to the dial, *z*, and the hands are united by means of gear wheels. In this way 1,000 or more hours can be registered.

In order to prevent the telephone from being used before the clock has been wound up, advantage is taken of the diminution of the tension of the spring, C, that occurs when the clockwork movement is stopped. To this effect there is used a claw bar carried by a lever, H, which is capable of revolving around the axis of the main spring of the clock or around any fixed point whatever. The free lower extremity of this stop lever, H, is capable of oscillating between two spring tappets. The tappet to the right, which opposes itself to the pressure exerted by the stop lever, is provided with a stronger spring than the tappet to the left. When, after the stoppage of the clock, the pressure of the stop lever no longer exists, the free extremity of the lever, H, displaces itself toward the tappet to the left, and then, owing to the motion of the spring of the tappet to the right, a stop, R, places itself in the hollow, E, of the rod, L, which latter is blocked in its turn, and the contact of the lever, A, with terminal of the telephone conductor, *t*, is interrupted.

The prolongation, *h*, toward the top of the lever, H (detail to the left), serves to move the sign disk, N, which is habitually found in a position of equilibrium, and is capable of revolving around a pivot. Thanks to the extremity, *h*, this disk is, in fact, displaced from its position of equilibrium, so that it comes in front of an aperture protected by a glass and gives the signal to wind up. Upon introducing the clock key, G, one acts upon a small lever, whose second arm, B, longer and more elastic, pushes the disk, N, back to its position, where it is no longer visible from the exterior, and holds it there while the clock is being wound up.—*Les Inventions Nouvelles.*

[Continued from SUPPLEMENT 943, page 15069.]

STUDIES OF THE PHENOMENA OF SIMULTANEOUS CONTRAST COLOR; AND ON A PHOTOMETER FOR MEASURING THE INTENSITIES OF LIGHTS OF DIFFERENT COLORS.*

By ALFRED M. MAYER.

The duration of the time of vision necessary to perceive contrast color.—A square screen was made, as shown in Fig. 10, with a square of cardboard in its center, 8 cm. on the side, surrounded by a square of translucent white paper, 35 cm. on the side. This screen was placed between the petroleum flame and the window so that its sides were equally illuminated. On the side facing the window the central square appeared cyan blue. One-half of this square was covered by a strip of paper so tinted with orange yellow that it appeared gray when in juxtaposition with the other blue half of the square.

On a rotator was placed two superposed black disks of the same diameter (25 cm.) Near the periphery of each disk was cut out an annular slot, 4 cm. long and 6 mm. wide, as shown in Fig. 11. By turning one of these disks on the other the opening of this slot could be varied from 4 cm. to nothing. The rotator is so made that the time of a rotation of the disk can be held uniform and also accurately measured. On gradually narrowing the opening in the slit the duration of vision of the blue and gray square was reduced to $\frac{1}{1000}$ of a second, when the blue half of the square could not be distinguished from the gray half.

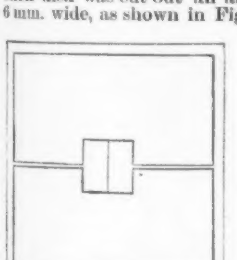


FIG. 10.

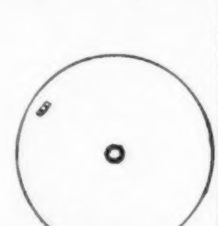


FIG. 11.

When the screen was illuminated by a more orange light, obtained by placing a sheet of orange gelatine between the lamp and the screen, the gray and blue were not distinguishable when the duration of vision was $\frac{1}{1500}$ of a second.

In these experiments I only got 11·6 flashes of light from the screen in a second, while the number of flashes required to banish all flickering from the screen was accurately measured as 46 in a second with the illumination of the lamp alone, and 42 in a second when the lamp light traversed the orange gelatine film. These experiments show, what is well known, viz., that as the intensity of the light diminishes the duration of no perceptible change in the intensity of the residual impression increases. I found that the sensation of the light from a white cloud seen, near noon, through a north window on a clear day lasts only $\frac{1}{18}$ of a second before the residual effect diminishes.

A gray ring was placed on an emerald green ground facing the light from a bright white cloud. When viewed through the opening in the rotator the ring appeared pink on the green ground till the duration of the vision of the ring was reduced to $\frac{1}{5150}$ of a second, when the ring ceased to be visible on the emerald green ground; but so long as it was visible the contrast color was visible. I found that 43 flashes per second were necessary to render the vision of the pink ring and green ground steady, without the least flickering, while only 11·6 flashes per second were obtained in determining the $\frac{1}{5150}$ of a second as the time when contrast color ceased to be visible. The fact that the contrast color of the ring remained till the ring could not be distinguished from the green ground gave the opinion that I ceased to obtain contrast color because the narrow slit used gave too little light to the eye. On doubling the width of the slit and doubling the velocity of rotation the contrast color of the ring reappeared, though the duration of vision was the same as in the former experiment.

Experiments on simultaneous contrast colors produced by the flash of the electric discharge.—The foregoing experiments having proved insufficient to form any opinion as to the time of vision necessary to perceive simultaneous contrast color, I made the following experiments with the light obtained by the discharge of a Holtz induction machine.

1. The gray ring was placed on the emerald green ground near a Holtz machine, which gave a very bright flash of 8 cm. long. The condensing surface on the two jars connected with the electrodes of this machine equaled 135 square centimeters. Professor O. N. Rood* measured the duration of the flash of Leyden jars of 738 and 71 square centimeters of surface, charged by an inductorium. The durations of the discharges of these jars were respectively $\frac{1}{5760000}$ second and $\frac{1}{28600000}$ of a second. From these measures I infer that the duration of the flash of the Holtz machine did not exceed the $\frac{1}{15000000}$ of a second. With short striking distances between the electrodes the flash is formed of several separated acts, as shown by Henry,† Feddersen,‡ Rood,§ and Mayer.‖ In the case of the discharge of a large inductorium the writer ‖ has shown that when the striking distance between brass ball electrodes is only one millimeter, with a Leyden jar of 242 square cm. of surface in the circuit the discharge lasts $\frac{1}{24}$ of a second and is formed of over 120 separate sparks; but as the striking distance is increased the discharge is formed of fewer and fewer components, till at a striking distance between 1 and 2 cm. the discharge is reduced to a single flash. In the following experiments the striking distance is 8 cm., and a single flash was given, whose duration we may safely assume was less than $\frac{1}{1000000}$ of a second.

In a dark room, at night, the flash of this machine gave vivid contrast colors. The gray ring appearing bright pink on an emerald green ground, and of a bright yellow on an ultramarine ground. The after images of these effects lasted about half of a second.

2. A rod was placed in front of a white cardboard and the shadow of the rod was formed on the screen by a candle. The distance of the candle was such that the white cardboard appeared equally brilliant when illuminated only by the candle or only by the electric flash. At the moment of the flash the appearance presented was very remarkable. From the shadow of the candle appeared suddenly to shoot a dark screen, which had superposed the shadow of the candle, and which shot to the side of the shadow and appeared of a bright golden orange, while the apparently uncovered shadow of the candle appeared of a brilliant cobalt blue; to my eye exactly as though an opaque screen had been suddenly removed from a slit in the shutter of a darkened room, which slit was covered by a piece of cobalt glass.

3. A square of thin green glass, 4 cm. by 6 cm., was placed on a piece of thin silvered glass, 4 cm. by 12 cm., so that the edges of the green glass and of the silvered glass coincided. This arrangement gave a surface half of silvered mirror, half of green glass. This apparatus was so placed that the electrodes of the machine and the flash were reflected from it to the eye. The room was dark. At the moment of the flash its reflection appeared as in Fig. 12. On the mirror the line of the discharge was white; W in the figure. The continuation of this line on the surface of the green glass appeared red (R in figure), though really white. In front of and parallel to this line was a green line, G, produced by the light of the flash reflected from the surface of the silvered mirror, and having traversed twice the thickness of the green glass. In this experiment we obtain contrast colors in the source of light itself.

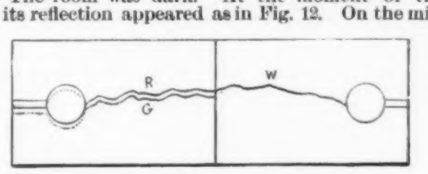


FIG. 12.

The explanation of the phenomena of simultaneous contrast colors, as generally given in works on chromatics, is that they are due to "error of judgment," to "deception of judgment," or to "fluctuation of judgment." The reasoning given may be convincing if all the conditions really exist which the writers assume to exist in their explanations of these phenomena. One of these conditions is that a judgment can be formed in the minute interval of time only necessary in which to perceive contrast colors. In the experiments just described with the electric flash we have *apparently* instantaneous perception of the contrast colors in the gray ring placed on the green and ultramarine grounds, in the candle and electric light shadows, and even in the very flash itself when this is seen reflected from the top surface of a green glass and from the mirror on which the green glass rests.

Many careful experiments made by me and others, using as chronometer three pairs of forks of the octave UT_4, giving respectively 10, 12, and 15 beats per second, showed that certainly the interval between the flash and the perception of the colors was less than $\frac{1}{15}$ of a second. Indeed, on viewing the flash and the illuminated surfaces at the same time, or hearing the discharge and viewing only the illuminated ring, *no interval could be detected* by this mode of observation as existing between the instant of the flash and the perception of the colors, and we certainly could have detected a shorter interval than $\frac{1}{15}$ of a second had it existed.

It is here to be noted that, although the after images of the contrast colors in these experiments with the electric flash lasted about one-half of a second, yet the most careful scrutiny could detect no change in sensation at and immediately following the flash. The contrast colors, so far as I and others observed, appeared at the moment of the flash. After the instant the image of the flash is formed on the retina there exists, no doubt, an interval of time before we are conscious of the stimulus, whose effects are seen rapidly to rise and then more gradually to fall, falling with two oscillations in intensity, so that all the events of the phenomenon take place in about one-half of a second. However, no vague impression of surfaces merely differing in illumination and then suddenly changing into a color and its contrast color could be detected. I think that this interval of no color sensation, if it exist, must be of exceedingly short duration; but such a period of light without color cannot be detected; and if it cannot be perceived, then, so far as we are concerned, it appears to me that there can be no hesitation in the perception of the colors, and no "fluctuation of the judgment" and "dividing between two images the difference in color which really exists" before the mind reaches its conclusion as to the character of the colors.

The following experiments were separately made on three persons between whom no communication had passed as to the nature of the experiments to be tried on them. I placed a gray ring on an ultramarine disk in front of the Holtz machine and requested the observer, who had explicit confidence in my truthfulness, to describe to me as accurately as possible the exact hue of the pink, or rose color, or red he would see on a green ground at the instant of the electric flash. Each observer at once said: "It is not pink; the ring appears yellow on a blue ground." Now in each of these experiments the observer was prepared, by my pardonable lying, to see red on a green ground; and to see yellow on a blue ground his mental condition of anticipation to see red on a green ground was first removed, then a new departure was taken and a judgment formed which resulted in his seeing yellow on a blue ground, and all that in a minute interval of time.

I do not know if psychologists have come to a conclusion as to the smallest interval of time necessary to form a judgment, either true or false, or in which to have a "fluctuation of the judgment," or in which "to exercise judgment and divide between two colors the difference in colors which really exist." If such mental operations can be performed in the millionth, the thousandth, or even in a few hundredths of a second, then the explanations of these phenomena, as generally given, may be convincing.

Von Bezold, in his "Theory of Color," Boston, 1876, in explaining the fact that a rod seen by reflection from a piece of green glass laid on a mirror gives two images, one green the other red, says: "As the observer does not *know* which of the two images is the colored one he exercises his judgment, and divides between the two images the difference in color which really exists." Now this experiment is similar in its conditions and in its effects of contrast color to the one I made on the contrast colors of the electric flash, when the same colors were distinctly seen apparently at the moment of the discharge. Can one "exercise his judgment and divide between the two images the difference in color which really exists" in an interval of time which is less than $\frac{1}{15}$ of a second?

In the experiment of the colored shadows cast by the candle and by daylight, these colors are explained by Von Bezold (pp. 152, 153), as follows: "The spot occupied by the blue shadow is illuminated by the *white daylight*, the larger white surface by *daylight and by candle light*, the other shadow by candle light only. It might be presumed, therefore, that one of the shadows would appear white, the other yellow. This is not the case, however: for *knowing* the surface to be white, we still take it to be white after it has really received the yellow light of the candle. Our judgment is led astray regarding white, and hence we believe the place occupied by the second shadow to be blue, although it is actually white."

Helmholtz ("Lectures," New York, 1873, p. 267), says: "Thus in the experiment described above of colored shadows thrown by daylight and candle light the doubly illuminated surface of the paper being the brightest object seen, gives a false criterion for white. Compared with it, the really white but less bright shadow thrown by the candle looks blue." These explanations assume knowledge and conditions which are not essential. If this knowledge and these conditions were necessary to see the phenomena, then these explanations of the phenomena might be convincing; but the conditions they assume are not necessary. The following experiments show that there is no necessity at all in "knowing the surface to be white" or to see "the doubly illuminated surface of the paper."

The experiment of the colored shadows cast by the candle and by daylight was arranged behind a screen, so that no one could divine what was there. A tube blackened on the inside went obliquely through the side of the screen, and was so adjusted that the circular field of view through the tube was entirely filled by equal portions of the two shadows, which formed two semicircles, one colored orange, the other blue. The two persons on whom I experimented were ignorant of the phenomena of contrast color and, moreover, were misled as to what they would see on looking into the tube, and I was specially careful not to speak to them about color. These persons were strangers to each other and neither knew that the other had been the subject of my experimenting. The first observer at once reported: "I see a circle half yellow and half blue." The other said: "I see a golden band next to a sky blue band, and the golden band is rather deeper in color where it is next to the blue," which is certainly a very good description.

Having in mind the facts established by the foregoing

* From the *American Journal of Science*, vol. xlvi., July, 1893.

* This Journal, September, 1871.
† Proc. Amer. Phil. Soc., 1843.
‡ Pogg. Ann., vol. cxvi. p. 132.
§ This Journal, Oct., 1872.
‖ This Journal, December, 1874.

experiments, it seems to me that we have either to regard the phenomena of simultaneous contrast color as psychical phenomena of which no satisfactory explanation has been given, or we must discard the Young-Helmholtz hypothesis of color sensation and adopt one similar to that of Hering, which gives a direct physiological explanation of contrast-color effects without the psychological considerations which those who adopt the Young-Helmholtz hypothesis are obliged to resort to in their explanation of these phenomena; and which explanations, as I have attempted to show, are faulty, and have to be modified to be convincing.

According to Hering's hypothesis of color sensations, when a portion of the retina is stimulated, adjoining portions of the field of view are affected by a sort of inductive action; so that changes are produced which are antagonistic or complementary to those portions of the retina actually stimulated.

M. Foster, in his "Physiology," Lond., 1891, Part IV., bk. III., gives an excellent discussion of the relative merits of the Young-Helmholtz hypothesis and Hering's in explaining color sensations. In conclusion he writes: "So far as we are aware, no crucial test between the two has as yet been brought forward. We may now leave the matter with the remark that while the Young-Helmholtz theory tends to lead us direct from the retinal image to the psychological questioning of the sensations, and seems to offer no bridge between the first step and the last, Hering's theory is distinctly a physiological theory, and at least holds out for us the promise of being able to push the physiological explanation nearer and nearer home before we are obliged to take refuge in the methods of psychology."

(To be continued.)

[Continued from SUPPLEMENT, No. 943, page 15077.]

ALLOYS.*

By Prof. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S.

Lecture III.†

IN the last two lectures certain methods of investigating molecular change in alloys have been studied. It will now be well to direct attention to some of the effects of molecular movement in liquid, and even in solid metals and alloys. That the atoms of gases are in rapid movement may be readily demonstrated by any of the familiar experiments by which the diffusion of a light gas—such as hydrogen—through a porous vessel of clay increases the pressure in the interior of the vessel. It is less easy to demonstrate the molecular movement in metals, but it may nevertheless be done, as will be shown in the course of this lecture.

It has long been known that the vapor pressure of a liquid is decreased by the presence of salts in it, and Tammann has shown that the molecular diminution of vapor pressure of any one solvent is nearly equal in value when caused by similar salts. For details as to the elaborate investigations which have been made, the student must refer to such a work as that by Prof. Ostwald on "Solutions;" allusion can only be made here to a law of Raoult, which states that "the lowering of vapor pressures of solutions in different solvents is equal when the proportion of the number of molecules of the dissolved substances to the number of molecules of the solvent is the same." Ramsay has shown that this law of vapor pressure applies to metals. He dissolved metals in mercury. Two U tubes were used, each with one short closed limb and one open limb; one tube was filled with the amalgam to be examined and the other with pure mercury.

The two tubes were placed side by side in a bath of mercury vapor, and the difference between the heights of the columns was read off. In every case a diminution of vapor pressure was observed, and there was also evidence that the metals tend to form the simplest possible molecules, that is, molecules consisting of single atoms. The numbers found for the molecular weights of calcium and barium are very noteworthy, as they are about half as large as the atomic weights; the number found for potassium is also much smaller than the atomic weight. Aluminum and antimony show a tendency to form complex molecules, and this fact may be connected with the peculiar behavior already alluded to of antimony and aluminum in forming alloys with each other and with other metals, which bear strong resemblance to chemical compounds.

It may be well to add a brief but somewhat rough explanation as to the diminution of the vapor pressure of a solvent caused by the presence of a dissolved substance.

Take the case of a column of water partly filling a closed glass tube; molecules of water will fly off from its upper surface into the space above and will continue in movement. Some molecules hit each other, some rebound from the sides of the glass tube, while others return to the liquid itself. It will be evident that this molecular movement produces a certain definite pressure, and a state of equilibrium is established when an equal number of molecules leave and return to the liquid in a given time. If a salt is dissolved in the water, there is no longer a free surface of pure water from which molecules are evaporating, that is leaving the fluid, in virtue of their own molecular movement, but the surface is that of a saline solution and not that of a pure solvent, and there will be fewer molecules of water able to escape in a given time, as part of the area of the liquid surface is occupied by salt. There is the same opportunity as before for the bombardment of molecules and for their return to the liquid, but there is less opportunity for liquids to leave the solution; consequently, when equilibrium is established, it will be found that the pressure exerted will be *lower* than before, provided the temperature has remained the same. It will be obvious that the same argument applies to the passage of molecules from a surface of pure mercury compared with mercury containing dissolved metals; the molecules of the metal which is held in solution retarding the evaporation of the mercury, as the salt did that of the water.

It follows that the observed diminution in pressure of a solvent, produced by a given proportion of an added element, should enable the molecular weight of an added element to be calculated, because by the law of Avogadro, the number of molecules in a given volume of all gases is the same under equal conditions as to temperature and pressure; and, further, experiments prove that the small quantity of metallic impurity present in mercury is in a state similar to that of a gas. It follows that having ascertained the diminution of pressure produced by any given element, the molecular weight of which is accepted, it is easy to deduce the molecular weights of other added elements by observing the diminution of pressure they produce.

The view that the mode of existence of an impurity in a solvent is similar to that of gas leads to the consideration of the manifestation of pressure exerted within liquids, whether they be saline or metallic, and to this the name "osmotic pressure" has been given. In attempting to explain this, it is necessary to turn to the effect produced by ordinary saline solutions. Let the porous cell, *a* (Fig. 1), which has a semi-porous "membrane" of ferrocyanide of copper deposited in its walls, be filled with a solution containing one per cent. of nitrate of potash.

The whole cell is then immersed in water, a certain small quantity of which finds its way into the cell, and it will be found that the mercury in the manometer tube will rise thereby, indicating the existence of a pressure of more than three atmospheres within the cell. Pfeffer's* work is the most important in this direction, and to it the student should refer. Now, as Ostwald has pointed out, it was not until Van 't Hoff began to develop a theory of solutions on the basis of such phenomena that clear conceptions of the nature of the forces at work were formed, but in his hands the theory has proved to be very fruitful. First, it has been established that osmotic pressure is independent of the nature of the membrane. The amount of water which enters the cell is very small, and need not appreciably dilute the solution of nitrate of potash; water can, moreover, freely pass in or out of the cell. The osmotic pressure must, therefore, be a specific property of the substance in solution, and in this respect osmotic pressure resembles gaseous pressure.† It is not the place to demonstrate this, but let it be accepted that the molecules of the dissolved body do exert pressure; let us, therefore, examine what is the effect of molecular pressure exerted by a small quantity of one metal dissolved in a mass of a metallic solvent.

The presence of a salt in solution raises the boiling point of the solution, because in order to enable an equal number of molecules to fly off in a given time from the surface of a *saline* liquid as from a pure liquid (see *ante*), the temperature must be higher, for, as in the previous case of the depression of the vapor tension by the presence of impurity, there are fewer molecules capable of escaping from the surface of the solvent than there would be if the solvent were pure, and in order to produce sufficient molecular pressure, a higher temperature is necessary. Why then should the freezing point of the solution be depressed by the presence of impurity? The freezing point is influenced by external pressure, but is mainly dependent upon internal pressure within the liquid mass. Arrhenius has shown that in a very dilute solution of a salt, the salt is probably dissociated, its ions are free. It can be imagined that in a dilute metallic solution, say of lead in gold, the lead molecules are also free, and the lead molecules, behaving as gaseous molecules, exert very considerable pressure. It has been shown by Pfeffer's experiments, already referred to, that in the relations between a solvent and the dissolved substance very considerable pressure is exerted. Take the case of melted gold containing lead as an impurity. As the mass of gold containing lead is about to solidify, its molecules are striving, so to speak, to come into closer contact, but are prevented by the movement of the molecules of the lead, and before the molecules of the lead can be expelled from the gold ones, these latter must do work. The only energy available is that liberated when the gold changes its state from liquid to solid, and a portion of the latent heat of fusion is employed in doing this work of expelling the lead. The gold, on account of the internal pressure due to the lead molecules, exists as a fluid, at a lower temperature than it otherwise would; and, finally, when the gold molecules are ready to come to rest as a solid, they cannot possess the same kinetic energy as they would if the intruding lead molecules had not been present, because they have done work on the lead. The freezing point of the gold is thus lowered, and the energy for the expulsion of the lead molecules has been drawn from the latent heat of fusion.

In the case of a metallic mass with a small quantity of impurity, the action appears to be as follows: Suppose the metallic mass to be gold, and the impurity platinum. The mass cools and begins to freeze, pure gold separates (the analogue of colorless ice which would separate from a dilute solution of a colored salt), and the dissolved platinum is forced to occupy a smaller space. In order to effect this concentration, work has to be done by the freezing metal, part of the latent heat liberated by freezing is employed on the work of concentrating the platinum. The metal gold can, however, fall below its normal freezing point without becoming solid, if sufficient internal pressure is available to keep it fluid, and this pressure is supplied by the osmotic pressure caused by the movement of the particles of platinum.

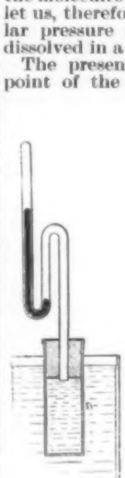


FIG. 1.

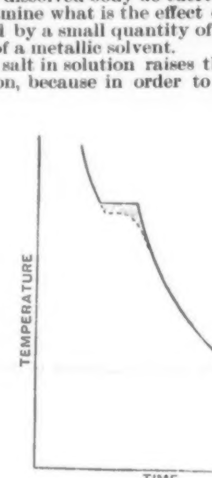


FIG. 2.

The main interest connected with osmotic pressure exerted in alloys is derived from the fact that the presence of a metallic impurity in a mass of a metallic solvent lowers the melting point. It may incidentally be observed that the curves of cooling obtained by the autographic recorder already described are of much interest in this connection, as they afford a measure of the heat liberated on solidification of a pure or impure mass of metal. Thus if the continuous line in Fig. 2 represents the cooling curve of very pure gold, and the dotted line that of gold contaminated with lead, then the shaded area will afford a measure of the heat expended in overcoming the osmotic pressure due to the added lead.

I have extended the work of Heycock and Neville to a solvent with a much higher melting point than they used, and have employed gold as the solvent, the measurements of temperature being made with a platinum rhodium thermo-couple, as has already been described.

It will be obvious that it is a very important advance to have enabled the changes which occur during the cooling of a mass of metal, with so high a melting point as gold, to be recorded automatically.

In my last course of Cantor lectures a description was given of certain attempts to separate the constituent metals of alloys by electrolysis. It was shown in some experiments made by myself that the action of a current of 300 amperes on an alloy of gold in lead, or of silver in lead, entirely failed to reveal the existence of the slightest separation of either of the metals from the lead. Other attempts have since been made by more than one experimenter, but, so far as I am aware, entirely without success. I also attempted to separate aluminum alloyed with gold, in a series of alloys which have since proved to be of a remarkable character; but hitherto the results of the electrolytic experiments have been absolutely negative. Before leaving the experiments connected with the passage of an electric current through an alloy, the following very interesting experiments of E. Warburg and F. Tegetmeier* deserve more than a passing notice. Their experiments would seem to demonstrate the possibility of producing eventually a degree of porosity in vitreous bodies which will admit the passage of elements having comparatively small atomic volumes, while other elements having larger atomic volumes are strained off, thus occasioning a mechanical sifting of the elements. A receptacle, Fig. 3, was

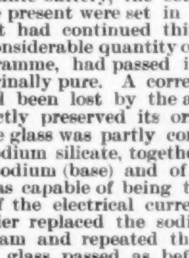


FIG. 3.

divided by a sheet of glass, which could be several millimeters thick. Sodium amalgam was placed on one side, and pure mercury on the other; the whole was then heated to the moderate temperature of 200° C., at which the glass becomes slightly conducting. By the aid of a Plante battery, the sodium atoms of the sodium silicate present were set in motion, and after the experiment had continued thirty hours, it was found that a considerable quantity of sodium, amounting to 0·05 gramme, had passed into the mercury, which was originally pure. A corresponding amount of sodium had been lost by the amalgam; but the glass had exactly preserved its original weight and clearness. The glass was partly composed of neutral molecules of sodium silicate, together with free molecules both of sodium (base) and of the acid, and the free sodium was capable of being transported under the influence of the electrical current. When, however, Tegetmeier replaced the sodium amalgam by lithium amalgam and repeated the experiment, the sodium of the glass passed as before into the originally pure mercury, and the glass became opaque on the side touching the lithium amalgam; but after a time the opacity extended right through the thickness of the glass, and then metallic lithium began to accumulate in the previously pure mercury. It is not possible thus to chase out all the sodium present in the glass; but the *free* sodium atoms are replaced by those of lithium. Analysis showed that the glass originally contained 2·4 per cent. of potassium and 13·1 per cent. of sodium, but after the experiment, while retaining the same percentage of potassium, it had 4·3 per cent. of lithium and only 5·3 per cent. of sodium. The glass in which lithium has thus replaced part of the sodium is very tender, and is opaque and friable. The conclusion is that the atoms of lithium, having an atomic weight of 7 and an atomic volume of 15·98, can pass along the tracks or molecular galleries left in the glass by the sodium atoms, the atomic weight and volume of which are 23 and 16·04 respectively. When a metal of superior atomic weight and volume to sodium is substituted for the lithium—such as potassium with atomic weight 39 and atomic volume 24—it is found not possible to chase out the sodium, the new atoms being too big to pass along through the spaces where the sodium had been. We are thus confronted with a molecular porosity which can, in a sense, be gauged; and the mechanical influence of the volume of the atom is thus made evident.

In this connection an almost forgotten experiment of Homberg's,† and a singular extension of by Guthrie, becomes of much significance. I have elsewhere directed attention to the fact that so long ago as 1713 the Dutch chemist Homberg wrote a remarkable paper "On substances which penetrate and which pass

* Lectures delivered before the Society of Arts, London, 1893. From the Journal of the Society.

† This lecture was an experimental one, and is here given in a somewhat abbreviated form.

* "Osmotische Untersuchungen," Leipzig, 1887.

† Van 't Hoff, "Phil. Mag.," vol. xxvi., 1888, p. 81.

* Wiedemann's "Annalen," vol. xli., 1890, pp. 1-41. E. Warburg, "Galvanische Polarization." F. Tegetmeier, "Ueber die electrolytische Leitung des Glases und Bergkrystalls." Also "Revue Generale des Sciences," 1892, p. 515.

† "Mem. de l'Acad. Royale des Sciences," 1713 (vol. for 1739, p. 306.)

through metals without their being melted," in which he points to the singular rapidity with which mercury will pass through zinc. He shows that a bar of zinc, one inch wide and half inch thick, will be penetrated by mercury in thirty seconds, so that it breaks readily, although before the addition of the mercury the bar would bend double without any sign of fracture. Guthrie,* who does not appear to have been aware of Homberg's experiment, placed an amalgam of potassium and mercury, containing 1·34 per cent. of potassium, in a hollow cylinder of cast zinc, the walls of which were two millimeters thick and the thickness of the bottom ten millimeters. The amalgam was scraped upon the zinc so as to insure contact, and then covered with petroleum. The zinc cylinder was corked up and covered wth paraffin. It was placed in a beaker of distilled water, and after two months' standing, no potassium found its way through the zinc. Neither could mercury be detected in portions of zinc taken from the outside of the cylinder, though if the mercury had not contained potassium the zinc would have been completely disintegrated, or, as it were, "slaked" by mercury. Not only, therefore, did the potassium fail to follow the mercury into the zinc, but it prevented the mercury from entering the zinc at all. These experiments are of great interest and must be continued, with a view to ascertain the influence of the atomic volume of the metal added to mercury in preventing its penetration of zinc and other metals. It must be remembered that in the case of gold, sodium amalgam "wets" the precious metal more readily than pure mercury does.

(*To be continued.*)

DRAUGHT DOGS.

IT is a very curious spectacle to a stranger, to a Parisian especially, who visits Brussels, and particularly Liege, for the first time, to see in the morning innumerable small vehicles loaded with fruit and vegetables arriving at the market drawn by dogs, whose good-natured barking proves not only that they experience no fatigue, but, on the contrary, a genuine enjoyment. It is not only the kitchen gardeners and the peasants coming to the city that make use of this sort of haulage, for the butchers, the bakers, the coal dealers and the milkmen have no other means of carriage in order to serve their customers. Fig. 1, which is a reproduction of a snap-shot photograph, shows a milk woman and her dog cart.

As a general thing, each cart is drawn by but one dog, but there may be several. Thus, in a beautiful picture by Hermann Leon representing a relay of dogs, and that figured at the *Salon* three years ago, the team consists of five animals.

The dog thus employed at Brussels and in its vicinity for the traction of small vehicles is a strong and broad-backed mastiff, more squat than a large Dane or a German mastiff, generally of a dull fawn color or more or less black spotted with white, and with a somewhat short-haired and rough coat. However, the Brabant peasants do not appear to stick to one type of breed with fixed conformation, color and length of hair; provided he is strong and energetic, that is all that they require of their steed with claws and fangs.

Good specimens are sold at from $30 to $35. In the course of service these dogs are fed upon bread and horse meat, and their maintenance costs about a cent a day. The dead weight that they haul is, on an average, 650 pounds. Bulldogs haul a much greater weight.

These dogs are very zealous, and perform their duty with as much pleasure as hunting dogs do in following the trail of game.

An exercise which well exhibits their qualities, and shows the degree of emulation with which they are endowed, is that of the races that frequently take place as a consequence of challenges made by their owners. The racecourse is a highway and the goal is at a distance of one or two miles. All passers-by can enjoy the spectacle *gratis pro Deo*. The competitors place themselves in line, and the impatience of the coursers, which is manifested by voice and action, can be moderated only by vigorous applications of the whip. Finally, the signal is given and they start off at full speed with loud barkings. Falls are frequent, and the drivers often literally bite the dust; but the automatons in short blouse are quickly picked up and put back in their carts, exciting anew their vigorous steeds, and those that have the oftenest fallen are not for that reason the last to reach the goal.

The swiftness of a team of dogs is such that bets on speed have been made on a good horse harnessed to a cab against one of these teams and been won by the latter.

The Belgians say that a good draught dog costs less to keep and sells at a lower price than an ordinary ass, while at the same time often doing as much work. It is quite curious to find that, among civilized countries, Belgium is about the only one that exhibits to us the common spectacle of dogs in harness. Why is it repugnant to people in other countries? In reality (as says our friend Frechon *apropos* of a story that we shall mention further along), is the fact of putting a strong and vigorous animal, sufficiently fed and trained, in the thills of a small vehicle, and of imposing upon him a tractive stress proportional to his muscular power, so shocking in itself? Is it of a nature to give a disagreeable impression to the most sensitive of the members of the Society for the Prevention of Cruelty to Animals? Why does a dog, properly harnessed to a small vehicle adapted to his size, shock us more than an ass or a mule working under the same conditions?

In France the repugnance to harnessing dogs is intensified by the idea that it is forbidden. Now this question of jurisprudence was decided on the occasion of an occurrence to which we alluded above in quoting the words of our friend Frechon on this subject.

Mr. Francis Nantet, a Belgian man of letters, started from Brussels in a cart drawn by two dogs in order to visit the Universal Exposition, and, after seven days' travel, reached Paris. Mr. Nantet met with some obstacles that retarded his arrival, notably an incident that occurred on his passage at Louvroil (North). In this locality the mayor, relying upon the Grammont law, refused to allow the excursionist to continue his voyage unless he changed his means of locomotion. The traveler then conceived an original idea. He put his dogs in the cart and hauled them to the limit of the territory of the commune! Having thus got out of the jurisdiction of the mayor of Louvroil, he harnessed his dogs again and pursued his journey, taking care to steer clear of cities as much as possible. From Compiegne the excursionist telegraphed to his friends in Paris, who went in large numbers to await him upon the road at the moment indicated by him for his arrival. He effected his return by the same means.

The question of law raised by this original voyage had been settled this same year, 1889, on the 19th of January, by the court of appeals in a decision rendered under the following circumstances: A woman, Eugenie L——, had harnessed a dog to a small cart, weighing with its contents 130 pounds, and had made him travel seven miles going and coming. The dog had not been maltreated, had rested several times and had reached the end of his trip without apparent fatigue.

An official report had been drawn up, and the police court of Chateau-Thierry, impressed with the affair, concluded on a simple offense by its judgment of the 10th of November, 1888. The question having been carried to the court of appeals, the latter, on the 19th of January, 1889, rendered the following decision:

"The court, upon the plea drawn from the violation of the law of July 2, 1850, relative to the ill-treatment bestowed upon domestic animals, considering that Eugenie L—— has been prosecuted for having, on the 3d of November, 1888, caused a dog of medium size to draw a two-wheeled vehicle weighing, with its load, 130 pounds, for a distance of about seven miles going and coming, that the sole article of the law of July 2, 1850, punishes only ill-treatment practiced publicly and abusively upon domestic animals, that the sole fact of harnessing a dog to a vehicle would not of itself, and independent of all other circumstances, constitute an abusive ill-treatment, and that the judgment attacked states that no act of brutality or violence has been set up against the prisoner, for this reason overrules," etc.

Thus one can harness dogs in France and no one has any right to find fault with it, if the animals are not treated brutally. How unfortunate would the population of the Arctic regions, already so wretched, be without the dog! It is to them, indeed, that might be applied the adage of the ancient Aryans: "Man subsists only through the dog." In fact, it is their sole domestic animal. It takes the place with them of the horse and ox.

The dogs of Greenland, Siberia and Kamtchatka all belong to the same variety. They are from 20 to 24 inches in height and have a pointed nose, straight ears and long and thick hair (which is usually yellowish white), and scarcely differ from the wolf, except in their tail, which is curled upward instead of being pendent. The Eskimo dog is the type of them. We give an exact figure of one of them (Fig. 3) from a photograph. The Labrador dog is of the same group, but is generally of a dark fawn color.

It is harnessed to sleds called *sleigs* or *kometiks* (according to the locality) that dogs are employed in the Arctic regions (Fig. 2). Their harness consists of a simple leather band or breast collar, to which are attached simple ropes by way of traces. No bit, and, consequently, no reins, the voice of the master directing the coursers and his whip urging them on. The Eskimo traveler takes care to place at the head of the team an intelligent and faithful animal, which is charged with the duty of leading all the others. From 10 to 15 dogs, says Benedict Revoil, harnessed together and led by a "captain dog," make from 18 to 24 miles a day in draw-

FIG. 1.—DOG CART OF A BRUSSELS MILKWOMAN.

* "Phil. Mag.," vol. xvi., 1883, p. 321.

FIG. 2.—TEAM OF ESKIMO DOGS.

FIG. 3.—THE ESKIMO DOG.

ing a weight from 650 to 1,650 pounds over spaces covered with compact snow or over frozen rivers. After the snow has disappeared, the dogs are set at liberty and provide for their own subsistence. On the approach of the hoar frosts, they return of their own accord to resume their collar of misery. Their sense of smell is very acute and permits them to follow trails even in the midst of snowstorms and to carry the traveler to the hospitable roof toward which he is proceeding.

Mr. Victor Meunier, in one of his *Causeries Scientifiques*, describes a very curious means (if it is true, and the author has not allowed a braggart traveler to tell the tale) employed by the inhabitants of Labrador for exciting their dogs to run with greater speed: "Every inhabitant of Labrador keeps from ten to twelve dogs, which are his steeds, the only ones that he can have, and they serve him only during the winter. Six or eight are harnessed to a small sled in which the master places himself. The whip cracks and the team starts off like an arrow, and twenty leagues are traversed in the space of six hours. Now the following, according to a traveler, is the ingenious and insidious manner in which such continued rapidity is obtained.

"On the eve of the start, all the dogs are submitted to a rigorous fast, an empty stomach having good legs in the dog. I have said all, but it is necessary to except one, and that is the best runner, which the master takes ostensibly into his house and covers with caresses under the nose of its companions. So marked a preference fills the latter with a fierce grief that they promise themselves to make the favorite pay dearly for when occasion presents itself.

"This offers itself the next day when, harnessed to the sled, the jealous dogs see the privileged animal at their head. Scarcely is he in harness before the rest spring forward to devour him. It is for him to run and for them to follow, carrying along with the sled, which scarcely grazes the snow, the man, satisfied with the success of his ruse. It is thus that one works upon the passion of those poor animals . . . exactly like that of men."

Brehm gives other reasons, that are more probable, for the ardor of Eskimo dogs when they are harnessed.

"It is only by means of their dogs that the Eskimos are able, for their subsistence, to derive advantage from the feeble resources presented by the dreary country that they inhabit. During the short duration of summer they hunt the wild reindeer, whose flesh serves them as food and whose skin furnishes the best part of their clothing. In winter, when hunger, drawing them from their miserable huts, obliges them to go in quest of new provisions, they follow the seal into the retreats that this animal forms under the ice, or attack the bear that roams along the coast. Now all such resources would be denied them were it not for the courage and sagacity of their dogs. These animals perceive the hole of a seal at a distance of an eighth of a league and scent a reindeer or a bear at almost as great a distance. The eagerness that they possess for attacking the latter is such that, when they are harnessed to a sled, it suffices to utter the word *neuvrouk*, which is the Eskimo for bear, in order to cause the whole pack to start off at a full gallop. Moreover, such eagerness, in connection with the hunger by which they are continually pressed in winter, renders them difficult to control, so that if, in the course of their route, they scent a reindeer, bear, or seal, it is almost impossible to prevent them from running to make an attack."

The dogs are harnessed to the sled, continues Mr. Gerbe, Brehm's translator, from whom we borrow what follows, by means of a gear quite similar to the straps used by the water carriers and porters at Paris for drawing heir little wagon. It is a collar formed of two bands of reindeer or seal leather that pass around the neck, over the breast and between the forelegs, and then unite upon the shoulders, where they are attached to a strong strap whose other extremity is fixed to the sled.

When a team is formed, the most important point is to select a good leader. For this, no attention is paid to the height, age, or sex. What is looked for is that the dog shall be intelligent and have a good nose. When to these two qualities, which are the main ones, is added great strength, the animal is priceless. The other dogs are arranged according to the same principle, that is to say, they are placed so much further to the front in proportion as they have more intelligence and a better sense of smell. The most incompetent is placed at 10 feet only from the extremity of the sled. The leader is 20 feet from it and at about 2 feet from the rest of the team. As for the others, they are not arranged exactly in line; there are always several that draw abreast.

The driver of the sled is seated in front, leg here and leg there, his feet almost touching the snow. In his hand he carries a whip, 20 feet in length, inclusive of the handle, which is about 20 inches in length and made of wood or whalebone. It is only through long practice that it is possible to learn how to use such a whip; but the Eskimos are accustomed to the handling of it from childhood, and, with them, this forms an essential part of their education. Moreover, in driving their sled they avoid the use of it as much possible, and employ it only for correcting some dog individually, for it frequently causes trouble in the team. In order to make the dogs quicken their pace or to make them turn to the right or the left, the voice suffices. For this the Eskimos, like our carmen, have certain words that the dogs understand very well. The leader in particular is very attentive to them and hardly ever fails to obey, especially if, before giving the order, care is taken to call him by name. In this case, he is observed to turn his head over his shoulder, without, however, slackening his pace, as if to show that he has understood.—*P. Megnin, in La Nature.*

THE first discoverer of the diamond is said to have been a Hindoo named Hakim Fez. Certain it is that the diamond first began to be valued in Hindoostan. For centuries the mines of Golconda were the only ones known, but in 1727 the diamond mines of Brazil were discovered, and in 1868 the famous South African diamond mines were opened up for the first time.

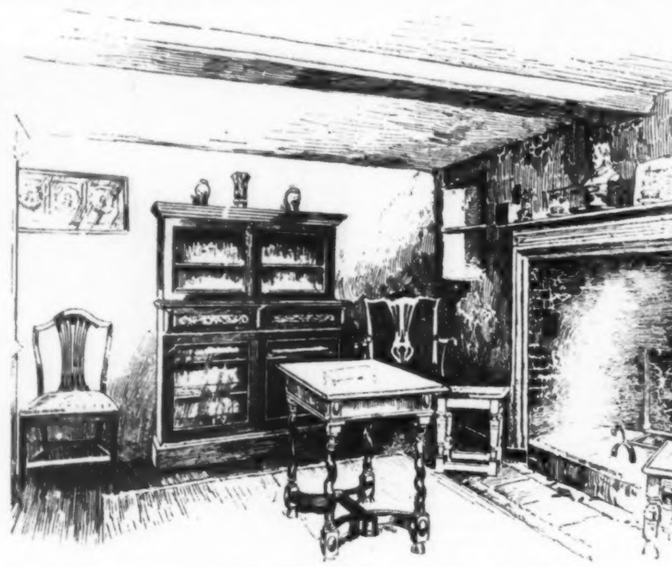
[From the Gardeners' Magazine.]

JOHN MILTON'S COTTAGE—A BUCKINGHAMSHIRE VILLAGE.

By J. T. Young, F.G.S.

CHALFONT ST. GILES AND JORDANS.

Chalfont St. Giles is only a small village in Buckinghamshire with a little over a thousand inhabitants—none of them known to fame; but to millions of the English-speaking race, on both sides of the Atlantic Ocean, it is a sacred spot. A cottage in the village itself and a small burial ground two miles distant are the points of attraction; the one was for a time the residence of John Milton, the other is the last resting



INTERIOR OF MILTON'S COTTAGE.

place of William Penn, the founder, rather more than two hundred years ago, of Pennsylvania. Chalfont St. Giles is, however, worth a visit on its own account, and it is more quickly and easily reached now than it was in the seventeenth century, or even a few years ago. By road it is between twenty-two and twenty-three miles distant from Hyde Park corner, the best route being along the Uxbridge Road through Ealing, Hanwell, Southall, and Uxbridge, until the eighteenth milestone is reached, when the traveler turns up the Amersham Road on his right hand, along which he must continue his journey for another four miles and a half before he arrives at his destination. He will not, however, think of going by road unless he be an ardent cyclist, and then the road will probably have greater attractions than the rail. The railway journey, nevertheless, has its conveniences and attractions. From Baker Street to Chalfont Road Station the journey occupies a little less than an hour, but the traveler may, if he prefers doing so, get out at Chorley Wood, the next station this side of Chalfont Road. In either case he will have about three miles to walk, and of the two the walk from Chalfont Road is perhaps the more enjoyable on a summer's day, though it is a trifle the longer. It is one of the special charms of Buckinghamshire and Berks that the scenery is so varied in its details that it reveals fresh features at every turn. Milton's "L'Allegro" accurately describes the feeling of every visitor who comes fresh from city life. He marks "the hedgerow elms and hillocks green," "the plowman near at hand," whistling o'er his "furrowed land," the mower whetting his scythe, or the shepherd "telling his tale" (counting his flock) and the "milkmaid singing blithe," and all the other scenes and features of rural life, according to the season of the year or the time of the day; but in no part of England that we are acquainted with are the words of the poet,

> Straight mine eye hath caught *new* pleasure,

more aptly suggestive.

The beech trees which abound in Bucks are one of the attractive features of the county—everybody knows Burnham Beeches, or ought to know them—and was it not long ago settled by authority that the name was derived from the Saxon word "Bucken," a beech tree? Other derivations, it is true, have been suggested, and it has been significantly remarked that the name of the county is, no doubt, derived from that of its chief town, and that there are no beech trees, at least not many of them, in the neighborhood of the town of Buckingham. For our own part, and as no one really knows, we prefer the old and most poetical theory, only if any reader should desire to have an alternative he may take the Saxon "Buccen" (deer), and remembering that King John is said to have had a hunting lodge close by Chalfont, the suggested derivation is not very farfetched. There is, besides, a third plausible theory, that Buckingham was at first "Bock-ing" (a charter meadow) with the common Saxon suffix "ham," indicating a mansion or "vil."

The three miles' walk from the station brings the visitor into the Amersham Road, opposite the Pheasant, a solitary wayside inn, where he may, if he wishes, generally obtain fairly good accommodation. By the side of this house a road descends directly into the village, which is built on either side of a street, which, if followed, leads to Beaconsfield, about three miles distant. There is a small pond on the green at the entrance of the village; a few shops of the type ordinarily found in small country places represent the trading element of the community, and what seems an unnecessary number of beershops and inns is one of the first features likely to attract attention. There is not, however, any superfluous accommodation for visitors, now that the place is more frequented if not better known than it was when the nearest railway station was seven miles distant. The writer visited it twice in August last, and found each time that its resources were overtaxed, and that visitors who had come to spend the Saturday and Sunday at Chalfont were obliged to seek accommodation at Amersham. The old church of St. Giles is half hidden by the houses on the south side, and is approached through an old lych-gate by the side of one of the half-timbered build-

JOHN MILTON'S COTTAGE.

ings still left. The village is evidently brightening up under modern conditions, for there are not only new buildings in the course of erection in the neighborhood, but there are signs of modern growth and of new ideas in the village itself. The old school, founded and endowed by Sir Hugh Palliser, has been removed to new quarters, and the school room in the center of the village, before which, by the way, a magnificent old elm stands, has been turned into a reading room.

At what was one time the further end of the village stands Milton's cottage. It is the only one of the numerous residences of the poet which remains—the rest have disappeared. We give two views of it—one as it now appears and the other from an engraving dated 1795. Comparing them, it will be seen that besides the addition of an inclosed garden, there have been some structural alterations. The older engraving shows a porch in front of the building, which is absent in the second; it had fallen into a ruinous condition and was cleared away a number of years ago instead of being restored. A small wash house or kitchen has also been added at the farther end, and the house itself has been divided into two tenements, the front part—consisting of two rooms on the ground floor and two above used as bedrooms—being shown as Milton's cottage. Here the poet may have put the finishing touches to his "Paradise Lost;" here certainly he meditated his "Paradise Regained," and almost as certainly wrote part if not the whole of it. Milton, the cottage, "Paradise Lost" and "Paradise Regained" become associated with the burial ground at Jordans through Thomas Ellwood, the Quaker, who was interred there. Ellwood had been introduced several years before to Milton as a young man who would gladly read to him for the advantage of receiving in return some instruction, in Latin especially. Milton accepted his services and they grew friendly through the young man's frequent visits. In 1665 the plague broke out, and spread so alarmingly that all who could leave London were glad to do so. At Milton's request, young Ellwood, then in South Bucks, rented this residence, "a pretty box" he called it, for his friend, and some time in the month of July, Milton with his wife and three daughters took possession of it. Those were troublous times for Quakers. Before Milton arrived at Chalfont St. Giles, Ellwood was in prison, and it was not until a month or so later that he was able to pay the poet a visit. When he did so, Milton lent him the manuscript of the "Paradise Lost" to read, and on his subsequently returning it, Ellwood expressed his admiration of the poem, adding however, "Thou hast said much here of 'Paradise Lost,' but what hast thou to say of 'Paradise Found'? He made no answer," says Ellwood, who tells the story in his autobiography, "but sat some time in a muse; then broke off that discourse, and fell upon another subject. After the sickness was over, and the city well cleansed and become safely habitable again, he returned thither; and when afterward I went to wait on him there (which I seldom failed of doing, whenever my occasions drew me to London) he showed me his second poem, called 'Paradise Regained;' and in a pleasant tone said to me, 'This is owing to you; for you put it into my head by the question you put to me at Chalfont, which before I had not thought of.'" "Milton's room," in which we may imagine the conversation to have taken place, is indicated by the farthest window in the engraving. Not much of the original furniture remains—two stools and a small table are exhibited as such, and appear to be genuine. The quaint open fireplace is unaltered, and the window with its diamond panes is pretty much as it then was. On the walls are some portraits and pseudo-portraits of the poet; a glass case with a few books in it stands under the window. There is among them a copy of the first edition of "Paradise Regained," two volumes which are said to have formed part of Milton's library, one with his initials on the title page, and some other things of no special note. Against the wall is a small bundle of pikes, which used to be preserved in the church, and several small cannon balls dug up in the neighborhood are also exhibited as mementoes of the civil wars. At the farther end of the room is a book case of later date containing a few books. The room on the opposite side of the doorway is much larger, and is used as a living room. The house before it was divided contained four sitting rooms and five bedrooms—some of these latter small enough to be more accurately described as closets. The garden contains some very nice fruit trees, and a plum tree has been trained over the front. The flowers are all common garden varieties—sunflowers, dahlias, lavenders, etc.*

Leaving the cottage and following the main road, which begins at this point to ascend, we pass first the Congregational chapel, and a little afterward the Primitive Methodist chapel; and some cottages which generally appear to have had a modern origin, then past a fine orchard, and presently by some half-timbered buildings which, with the cottages close by, form the hamlet of Households; the most remarkable feature being the ruinous condition of the old buildings, which sadly need repair. A little beyond, a sign post points the way to Jordans, down the road on the left hand. The visitor will need no further guide—he will walk along the charming country road for between a mile and a mile and a half, possibly without seeing a single soul, but if he be a lover of nature, he will not feel the want of society, and may be none the less in a fitting frame of mind to appreciate Jordans when he reaches it. It is simply an old-fashioned plain brick meeting house, lying a little off the roadside on the left hand, and in front of it a burying ground, recognizable as such because of a few grave mounds and several small headstones. At first sight the visitor marvels there should have been so few interments—apparently something between twenty and thirty, and of these the larger number lying near together. Supposing, however, he allows his eye to become a little more familiar with the ground, he will see signs of graves all over it—though the original mounds are in most cases nearly obliterated, and those which stand out so conspicuously do so because they have been restored. Altogether there have been 332 interments since the acquisition of the ground, and the erection of the meeting house in the reign of James II. Among the restored graves is that of Thomas Ellwood, who died in 1713, and that of a much greater man, William Penn, who was interred here in the summer of 1718.

So much of Penn's story as concerns us just now is soon told. He belonged to an old family, and was the son of an English admiral. He was partly educated at Oxford, but was expelled from the university because, under the influence of a Quaker preacher, he refused to wear the college cap and gown; then he was sent by his father to France, where he continued his studies for two years, was presented at the French court, and returned to England, and was introduced to court life here. The crisis of his religious experience was in the plague year, 1665; for while Milton was at Chalfont, Penn was in Cork, where he came once more under the spell of the Quaker preacher, Thomas Loe. How he threw in his lot with the despised Friends; how he was imprisoned on a charge of blasphemy; how in time he became reconciled to his father, old Admiral Penn, who had turned him out of doors when he became Quaker; how Penn married Gulielma Springett, whose remains now lie in the Jordans burying place; how, in spite of his Quaker principles and notwithstanding that he would not remove his hat even in the presence of royalty, he gained influence at court, and preserved the friendship of James II.; how three out of the five children of Penn, also buried at Jordans, were born to him while he lived at Rickmansworth; how while he resided there he dreamed of a land of liberty and peace, of religious and civil freedom, beyond the Atlantic can only be hinted at here. The realization of his dream was rendered possible by the fact that when Penn's father died, Charles II. owed the admiral £16,000, and was more willing than able to pay. He, therefore, made over a wild tract of forest land in America to William Penn, measuring three hundred miles by one hundred and sixty miles, now indicated on the map as Pennsylvania. There were a good many settlers there already—English, Dutch, and Swedish, and there were the Indians also, who had more territorial rights than Charles, and whose claims were seldom much regarded by early European colonists. How considerate he was of these is a matter of history, and in the Jordans meeting house hangs a copy of the well known picture which represents Penn negotiating the treaty of peace and friendship with the Indians, which was so faithfully kept by both parties. Three and twenty shiploads of emigrants, mostly, if not all, Quakers, arrived during the summer of 1683, and so was Philadelphia, the first settlement of the colony, founded, and if there are but few Quakers now in Buckinghamshire, the old families are still represented by their descendants in the United States, and especially in Pennsylvania, with its five millions of population. For the rest, it will be enough to say that Penn returned to England, and after about ten years went back to Philadelphia, where, we are told, he was honored as a governor and loved as a friend by all around him. In 1701 he came back to this country to defend his rights and those of his fellow colonists. Domestic troubles, fraudulent claims, and consequent financial embarrassment and imprisonment in the Fleet, embittered his life and brought on paralysis, and he spent the last five years in seclusion at Ruscombe, near Twyford. Something of all this comes to one's memory as, standing inside the little burying ground, the eyes rest upon the grave mounds and the small memorial stones with the names of those whose remains lie beneath the grass—Joseph Rule, Isaac Penington, and Mary Penington, then Gulielma Penn, the first wife, and under the next mound William Penn and his second wife. Behind these are stones with other well known names, and among them those of Thomas Ellwood and his wife. The latest interments are those of the late Mr. Masterman, the banker, and his wife, between forty and fifty years ago.

MILTON'S COTTAGE. (From an engraving of 1795.)

Of the meeting house itself there is not much to be said. It is as plain as it well can be, inside and out; the window panes are diamond shaped, and the furniture consists of plain forms with backs to them, and a table. At the end of the meeting room it is divided by wood paneling from the part used as a dwelling for the caretaker and his wife; but portions of this paneling are removable, so as to enlarge the accommodation by opening up the dwelling rooms. There is not, however, much need for this, for there are no services there now excepting once in the year—in the month of June—and then all the available space is wanted, for Friends come from considerable distances to unite in the annual service, and the old-fashioned stable at the back with stall room for twenty horses is all too small. It is not surprising that the people of Pennsylvania should have entertained the wish to remove the remains of William Penn to Philadelphia, and in 1881 Mr. G. L. Harrison was empowered to visit this country to obtain if possible permission to disinter his bones and convey them across the Atlantic—though it would have been strange if the request had been complied with. As might have been expected, the application was refused, and they still remain undisturbed in their original resting place.

From Jordans the visitor may, if he likes, walk to Chalfont St. Peters, a direct road to which runs by the side of the meeting house; or, returning to Chalfont St. Giles, pay a visit to the ancient church, in which he will find nothing more quaint than the old sexton, John Clark, who will show him all that is worth seeing, commencing with the Norman font, at which, he says, "I was baptized in the year 1811." He will have something to say also about the half defaced frescoes on the walls, the tombs of the Fleetwoods, who used to reside at "The Vach," and whose arms are on the front of Milton's cottage; he will point out the tomb of Francis Hare, Bishop of Chichester, who died in 1740, and a recent tablet to John Milton, in memory of his residence in the village. Then, if the visitor cares to walk out with him into the pretty churchyard, he will find that his memory is stored with recollections of many of those who are sleeping their last sleep beneath the green turf. Thence he should go to "The Vach," as the former residence of the Fleetwoods is called. To do this, he will leave the village and walk about a quarter of a mile down the high road in the direction of Amersham, pass through the park gates, and up a long and beautiful avenue of limes. Of the house itself he will only see the front, and the best view of this will be gained from the monument to Captain Cook, erected by Admiral Palliser, who was living at "The Vach" when his friend died. There is not much, however, of special interest in what can be seen of the house from the outside, and what there is arises from the memories it awakens, and the illustration its history affords of that "Mutabilitie," of which Spenser sang so impressively:

Then gin I thinke on that which Nature sayd
 Of that same time when no more Change shall be,
But stedfast rest of all things firmly stayd
 Upon the pillours of Eternity,
That is contrayr to Mutabilitie,
 For all that moveth doth in Change delight.
But thenceforth all shall rest eternally
 With Him that is the God of Sabaoth hight;
O that great Sabaoth God, grant me that Sabaoth's sight.

* In 1887 the cottage and grounds were purchased by subscription, and vested in trustees, for preservation and exhibition.

THE EFFICACY OF STATE FOOD LAWS AND THE DESIRABILITY OF NATIONAL ONES.

Within the last few years, several of the States in the Union have enacted laws designed to suppress or control food adulteration, and in some of the larger cities, local ordinances supplement these statutes. The legislatures that have given this subject any considerable attention have also provided a corps of officials to enforce the laws, and, as a necessary adjunct of the work, have either established chemical departments or have retained chemists whose province it is to determine when the laws have been violated.

If the various laws upon the subject were codified, it would be seen that the larger part of them are so similar as to suggest that they had been obtained from the same source, and such, indeed, is the case, the English food and drug act being the basis upon which they were framed.

New York and Massachusetts were the first States to give the matter attention, and they were followed by Ohio, Wisconsin, Oregon, Iowa, Minnesota and Michigan among the Western States. In several other States bills for food laws have been defeated, but the subject is attracting universal attention, and a movement is now on foot to bring the matter before the present Congress in an endeavor to obtain national legislation, which is desirable from several standpoints.

Before considering the desirability of national laws, it is well to review the efficacy of State enactments, to consider how they are evaded and the result of attempts at enforcement.

Probably no term is more generally misunderstood than the word "adulterated" when applied to food stuffs. The general impression conveyed is that the adulterated article is pernicious, unwholesome, dangerous and unclean, while the reverse is more often the case. A wish to obtain an abnormal profit is the cause of all food adulteration, and the same cause would argue against the use of any ingredient that would render an article unwholesome or unpalatable. There is certainly no market for a food that is nauseating or deleterious; and the first thought of the manufacturer is to avoid offending the taste or injuring the health of the consumer.

Over ninety per cent. of adulterated food is non-injurious to health, and the cases that occasionally arise where danger, however remote, is incurred are generally the results of gross ignorance or pure accident. The popular impression that death lurks within the coffee can or vinegar cask is attributable to sensational articles that have gone the rounds of the press and have originated in the brain of some reporter endeavoring to write up, under a "scare" head, a subject of which he was ignorant or concerning which he had been greatly misinformed. A few months ago a leading newspaper in Cleveland, O., published, under startling headlines, the results of the investigations of an Ohio chemist, and among other instances of depravity mentioned, several samples of vinegar were cited that "contained acetic acid and were over half water." As a matter of fact, the New York law permits 93½ per cent. of water in a cider vinegar and 95½ per cent. in a grain vinegar; acetic acid is the sour constituent of all vinegars and the only ingredient of hygienic value.

These sensational articles of the laity are not the only causes of misapprehension. Many chemists and officials, in reporting the results of their investigations, are betrayed into a warmth of expression that is not always warranted. It is hardly fair to brand a sample that falls a fraction of a per cent. below a State standard as "dastardly," "heinous," etc., and this is exemplified by again referring to vinegar. A sample that contains four per cent. of acetic acid (in grain vinegar) is standard in Wisconsin, but it cannot be sold in New York or Minnesota unless it contains one-half of one per cent. more acid.

The conflict of local laws is well illustrated here, for this sample, which may be sold as pure and standard vinegar in Wisconsin, is defined by legislative enactment as adulterated in the States of New York, Ohio, and Minnesota.

The publicity thus given to a grade or class of goods has often defeated the end the officials are striving to attain, as the consumer, hearing repeated tales of the impurity and bad effect of some class of goods that he habitually uses, and failing to observe the evil wrought in his own case, naturally concludes that the whole

thing is a hoax, and in future pays no attention to these reports. A possible advocate of reform is thereby converted into a non-believer and becomes a scoffer at organized effort to correct existing evils, arguing that he uses the food commonly found upon the market and that his father did before him with no evil results; and he therefore opposes the passage or execution of laws that are designed to protect himself and his progeny.

Another factor that exerts a large influence in curtailing the full benefit of the laws is the inherent antipathy of America toward laws that savor in the least of paternalism. In England, Germany, and France much more stringent laws are held in strict observance, but the people are accustomed to a monarchical form of government, and the restrictions imposed are consequently less irksome.

One of the difficulties encountered in punishing violations of the State laws lies in the construction of several of the statutes that fix an arbitrary standard of purity or strength for certain articles. The sale of goods not conforming to these requirements is made a misdemeanor, a quasi-criminal offense, and the dealer who unwittingly handles them and is detected is placed in the very unpleasant position of defendant in a prosecution of this sort. The Supreme Court of New Hampshire has held that this compulsory maintenance of an arbitrary standard is a valid exercise, by the legislature, of the police power for the prevention of fraud, and the New York law does not make fraudulent intent a necessary ingredient of the offense. Where such rigid construction of the law obtains, as a matter of justice and equity the standard should be a moderate one, based upon actual experience extending over a long interval and considering every phase of the article involved, and not a requirement founded upon a hypothetical standard of purity or strength that conforms with theory rather than the conditions commonly met with.

Undoubtedly a merchant is presumed to have sufficient knowledge to discriminate between genuine and spurious goods, but, on the other hand, it seems equally true that he cannot be expected to differentiate between a vinegar, for instance, that contains four per cent. of acetic acid and one that contains four and one half per cent. The estimation is one that requires a certain degree of skill in chemical manipulation, and beyond a mere guess, the retail merchant must rely upon the statement of the jobber or manufacturer from whom he buys, and who is frequently a resident of an adjoining State, where food laws are unknown or inoperative.

The system of State laws, differing like the inhabitants of ancient Gaul, *inter sese*, is productive of another evil. A grade of goods may be made and sold in Illinois that would not comply with the requirement of the Wisconsin laws, and if it is assumed that the demands of the latter State are reasonable, the goods must be sold to the Illinois consumer or in another State likewise unprotected, and one State is thus compelled to accept, consume and pay for goods that are contraband in another. This would be obviated by a national law.

Under the present system, a dealer in Ohio may purchase goods from a jobber in Indiana, and, should he violate a law in their sale, he has no redress beyond a suit for damages, involving a small amount, and entailing an expensive suit, and the official who prosecuted the retailer would be powerless to impose any restrictions upon the manufacturer, who is beyond his jurisdiction. Many retail dealers, against whom charges are preferred for this reason, enter a plea of guilty and pay a nominal fine, rather than incur the publicity that a contest would involve. The merchant thus fined relies upon the probity of his jobber to reimburse him for his loss, and uses a threat of transference of patronage as a lever to compel restitution. If the entire country were governed by the same law, action could be begun against the party really guilty, and the annoyance and ignominy would be spared him whose only offense was too implicit a trust in his jobber.

In a case of this sort, it is extremely doubtful if any real good has been accomplished, and it is more than probable that the retail dealer becomes inimical and his co-operation is lost—a matter of some moment, for the laws can become successful only through the friendly aid of the retail merchants.

If the retail merchant were to purchase exclusively from manufacturers in his own State, it would be possible to reach the party who is really responsible for the fraud, but this would be using the statute to unfairly influence the commercial relations existing between sister States, and would be unlawful. A national law would remove this fault also.

It has been argued that any law restricting the sale of food is contrary to public policy, and that each individual should have the right to determine for himself what he should eat. This reasoning would be sound if every one had attained sufficient skill to be able to judge the matter; but this is a very remote contingency, and one that need not be taken into consideration. Laws regulating the manufacture and sale of food are as necessary as city ordinances restricting the construction of buildings, and have the same end in view, *i. e.*, the safety of the public.

It has been asserted that the entire matter is one that pertains to the commercial world, and so long as an article is harmless it should be sold for what it will bring, without any legal restrictions. While the larger part of food adulteration is the mere practicing of a fraud in business transactions, and therefore amenable to the laws of commerce and barter and exchange, there is a phase that demonstrates clearly the necessity for legislative restriction, and an example shows this. If one cheesemaker produces a cheese from rich, whole milk and sells it for nine cents per pound, realizing a profit commensurate with his labor and investment, and a competitor produces a cheese made from milk from which he had previously removed all or a portion of the cream, which he converted into butter, the latter would reap a reward to which he was not entitled. It is true that the expert buyer would detect the removal of the fat and pay for the cheese accordingly; but when the cheese was put upon the counter of the retail merchant, the consumer, not possessing the experience and skill, of the wholesale buyer, would pay the same price for either, but in the latter instance he would be deprived of a normal ingredient that is of great value to the food and to which he was justly entitled. Not only is the consumer entitled to protection in his pecuniary dealings, but the scrupulous manufacturer is in vital need of the law to protect his honest industry from the more questionable one.

The work that has been done in the last ten years by State food bureaus has demonstrated the need of laws, and it has also shown the defects of local statutes and the want of national ones. The reports issued by these commissions show progress in the art of detecting adulteration, but what has been achieved in checking it, it is difficult to estimate. Certainly the number of convictions and the amount paid in fines are indications of progress, but frequently the cases are similar to those cited above, where a plea of guilty is made and a fine paid as the least public method of settling the matter.

Many existing laws are mere experiments and have paved the way, by their inadequacy or unfairness, for a law that shall be broad and comprehensive, yet specific enough to be effectual. Any law that may be framed upon this subject must meet with one obstacle that will tend to restrict effectual work, and that is the American jury system. The aversion to paternalism is so strong and the ignorance of the average jury so dense that a conviction is almost an impossibility until such time as the people shall have been thoroughly educated. There are exceptions, where prejudice enters into the case, but a prejudiced jury is manifestly an unfair one. It is comparatively easy to convict a milkman of watering or skimming his milk before a city jury, whose members buy their milk from the wagon, and twelve farmers will probably convict a manufacturer of adulterated goods, but if the conditions are reversed, an acquittal is almost a certainty.

Still another difficulty in accomplishing adequate results under the existing circumstances lies in the fact that when an offense is detected and an action instituted, the State is generally compelled to present its case through the prosecuting or district attorney of the county in which the law was violated.

It matters little how skillful an attorney may be or how well he may be read in the law. Unless he has had some experience in technical cases, he is at a tremendous disadvantage when conducting a case in which a life-long familiarity with the subject is on the side of the defendant. True, the experts and officials are present to testify in behalf of the State, but their knowledge and experience is useless unless it is skillfully brought out, and the attorney, cautiously feeling his way upon *terra incognita* is unable to take advantage of many opportunities that could be fully utilized by a lawyer whose business it was to conduct prosecutions under a national law, and who was thoroughly familiar with the techno-chemical questions involved.

A national law would be of vast benefit in the way of centralizing the work and lessening the expense of maintaining a corps of competent men, and, what is still more important, of improving the present methods of detection of adulteration and of devising new ones. In the chemical examination of foods it is much the same as in the art of war. No sooner is a gun invented that will penetrate any known form of armor, than an impenetrable armor is devised; and no sooner is a chemical method of detecting an adulterant perfected, than some genius produces a substance that is, for a time, comparatively safe from detection.

The chemist of a State food bureau is compelled to examine every article that is submitted, making hundreds of analyses each month; and working yesterday with vinegar, to-day with butter, and to-morrow with cream of tartar, he barely finds the time necessary to make a careful examination of each, and original work is out of the question. If the work were under government supervision, laboratories throughout the country could be fitted up for special work, and one chemist could devote his entire time to one line of food stuffs, and would thus be afforded ample time and opportunity to thoroughly investigate his specialty, and could keep pace with all that is being done.

A legal department would be a very necessary adjunct, and the attorney and his assistants could qualify themselves to conduct cases that require as much technical as legal knowledge.

In framing a bill for Congress, some radical departures from the State codes will be necessary, but the prime feature in any law that may be passed should be to construct a statute that is founded upon reasonable demands, based upon a thorough, practical knowledge of the properties and the process of manufacture of the article affected.

GEORGE S. COX,
State Chemist.

Madison, Wis., Sept., 1893. Wisconsin Dairy and Food Commission.

VITALITY OF CHOLERA ORGANISMS.

SOME interesting investigations on the vitality of the cholera organisms on tobacco have been made by Wernicke (*Hygien. Rundschau*, 1892, No. 21). Small pieces of linen soaked in cholera broth cultures were rolled up in various kinds of tobacco, and the latter made into cigars. At the end of twenty-four hours only a few bacilli were found on the linen and none on the leaf. On sterile and dry tobacco leaves the bacilli disappeared in from one-half to three hours after inoculation. On moist, unsterilized leaves they disappeared in from one to three days, but on moist and sterile leaves in from two to four days. When introduced into a five per cent. tobacco infusion (ten grammes of leaves to two hundred grammes of water), however, they retained their vitality up to thirty-three days; but in a more concentrated infusion (one gramme of leaves to two grammes of water) they succumbed in twenty-four hours. When enveloped in tobacco smoke they were destroyed, both in broth cultures as well as in sterilized and unsterilized saliva, in five minutes. Tassinari, in his paper, "Azione del fumo di tabacco sopra alcuni microrganismi patogeni" (*Annali deli Istituto d' Igiene*, Rome, vol. i., 1891), describes a series of experiments in which he prepares broth cultures of different pathogenic microbes, and conducted through them the smoke from various kinds of tobacco. Out of twenty three separate investigations, in only three were the cholera organisms alive after thirty minutes' exposure to tobacco fumes. But in actual experience the apparent antiseptic properties of tobacco have not unfrequently been met with; thus, during the influenza epidemic in 1889, Visalli (*Gazetta degli Ospedali*, 1889) mentions the remarkable immunity from this disease which characterized the operatives in tobacco manufactories; that in Genoa, for example, out of 1,200 workpeople thus engaged, not one was attacked; while in Rome the number was so insignificant that the works were never stopped, and no precautions were considered necessary.—*Nature.*

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